Chestnut Creek Watershed Bacteria and Sediment TMDL Implementation Plan Technical Report

Prepared by
The Virginia Tech Department of Biological Systems Engineering

In Cooperation With
The Virginia Department of Environmental Quality &
The Chestnut Creek IP Steering Committee

September 30, 2015

Acknowledgments

Many thanks to those who dedicated their time and efforts to the development of this plan:

Local residents and landowners
Carroll County
City of Galax
Grayson County
Master Gardeners of the Blue Ridge
New River Soil and Water Conservation District
Virginia Department of Conservation and Recreation
Virginia Department of Forestry
Virginia Department of Health

A special thanks to the following organizations for the use of their facilities for meetings:

City of Galax
Galax Recreation Center
Virginia Department of Forestry

For additional information, please contact:
Virginia Department of Environmental Quality
Chris L. Burcher, TMDL Nonpoint Source Coordinator
Southwest Regional Office
355-A Deadmore Street
Abingdon, Virginia 24210
276-676-4803
chris.burcher@deq.virginia.gov

List of Abbreviations

The following abbreviations are used throughout this document.
BMP – Best Management Practice
CREP – Conservation Reserve Enhancement Program
CRP- Conservation Reserve Program
CWA – Clean Water Act, the origin of the Total Maximum Daily Load Program
CWSRF – Clean Water State Revolving Fund
EQIP – Environmental Quality Incentives Program
FTE – Full Time Equivalent
GWLF - Generalized Watershed Loading Functions model
HSPF – Hydrological Simulation Program-FORTRAN
IP – Implementation Plan
LA – Load Allocation, the load allocated to nonpoint and background sources in the Total Maximum Daily Load Study
MOS – Margin of Safety, a load that represents uncertainty in the modeling process
NPS – nonpoint source, referring to diffuse sources of pollution, such as from runoff
NRCS – Natural Resources Conservation Service
SWCB – State Water Control Board
SWCD –Soil and Water Conservation District
TMDL – Total Maximum Daily Load (Study)
USCB – United States Census Bureau
USEPA – United States Environmental Protection Agency
VAC – Virginia Administrative Code
VCE – Virginia Cooperative Extension
VADCR – Virginia Department of Conservation and Recreation
VADEQ – Virginia Department of Environmental Quality
VDH – Virginia Department of Health
VDOF – Virginia Department of Forestry
VDGIF – Virginia Department of Game and Inland Fisheries
VDOT – Virginia Department of Transportation
VPDES – Virginia Pollutant Detection and Elimination System
WLA – Waste Load Allocation, the load allocated to point sources
WQIF – Water Quality Improvement Fund
WQMIRA – Water Quality Monitoring, Information and Restoration Act

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EXECUTIVE SUMMARY

Chestnut Creek, which is located in Carroll County, Grayson County and the City of Galax is part of the New River basin. An 8.69-mile segment of Chestnut Creek from Skunk Branch confluence to the confluence with New River is impaired for violations of the *Escherichia coli (E. coli)* water quality standard and the General Standard (benthic). An additional 3.19 miles of Chestnut Creek is also impaired for violations of the *E. coli* water quality standard. Chestnut Creek was originally listed as impaired on Virginia's 1994 Section 303(d) Total Maximum Daily Load Priority List due to water quality violations of the general aquatic life use (benthic) standard. In 2004, Chestnut Creek was also listed due to water quality violations of the bacteria standard. The Virginia Department of Environmental Quality (VADEQ) completed the corresponding TMDL studies in 2006. The purpose of this Implementation Plan (IP) is to describe the actions needed to achieve water quality goals in the Chestnut Creek watershed and achieve fully supporting status for Chestnut Creek.

Review of the Chestnut Creek TMDLs

The Chestnut Creek watershed is located in Virginia's Carroll and Grayson counties, North Carolina's Surry and Alleghany counties, and the city of Galax, Virginia. It flows generally north to its confluence with the New River. The Chestnut Creek watershed comprises approximately 39,000 acres of land area with 7% characterized as developed, 36% agriculture and 57% forested according to the 2006 TMDL report (VADEQ 2006). Only 3.7% of the watershed is located in North Carolina. Chestnut Creek is impaired for violations of the *E. coli* bacteria water quality standard from the confluence with Coal Creek to the New River confluence, and impaired for violations of the General Standard (benthic) from the Galax raw water intake to the confluence with New River.

The 2006 TMDL study identified the primary sources of bacteria in Chestnut Creek as nonpoint source pollution, specifically agricultural runoff from pasture and croplands and failing septic systems. Other nonpoint sources of bacteria include direct deposition of livestock manure in streams, straight pipes, pet waste, and wildlife. A stressor analysis identified sediment as the most probable stressor for aquatic life in Chestnut Creek. The 2006 TMDL study identified the primary sources of sediment in Chestnut Creek as pastureland, cropland and streambank erosion.

The TMDL study included evaluations of several allocation scenarios for meeting both the bacteria and sediment TMDLs. The final allocation scenarios for meeting the bacteria and sediment TMDLs in Chestnut Creek were chosen by watershed stakeholders and updated during Implementation Plan development based on current BMP implementation practices in the watershed and concurrent planning to meet both the bacteria and sediment TMDL goals. These final allocation scenarios used in this Implementation Plan are located in Table ES-1 (bacteria) and Table ES-2 (sediment).

Table ES-1. Allocation scenario used in the Chestnut Creek Implementation Plan for meeting the Chestnut Creek bacteria TMDL

	Percent Reduction in Bacteria Loading					Percent Violations	
Stage	**Livestock Direct Deposition**	**Residential / Urban**	**Pasture**	**Cropland**	**Straight Pipes**	**GM > 126 cfu/100ml**	**Single Sample > 235 cfu/100ml**
1	65	26	55	21	100	29.6	20.4
2	65	86	87	21	100	0	10.3

Table ES-2. Sediment allocation scenario for meeting the Chestnut Creek sediment goals

Sediment Source	Future Sediment Load (tons/yr)	Allocation Scenario	
		Reductions (%)	Loads (tons/yr)
VA Pervious Area:			
Commercial and Residential	102.18	1	101.16
Disturbed Forest	447.58		447.58
Forest	17.14		17.14
Wetland	0.02		0.02
Pasture	5,541.00	35	3,601.65
Hay	193.27		193.27
Quarries	16.72		16.72
Row crop	1,664.55	29	1,181.83
Water	0		0
NC Pervious Area:			
Total	162.01		162.01
VA Impervious Area:			
Commercial and Residential	98.05	1	97.07
NC Impervious Area:			
Total	0.32		0.32
Streambank Erosion	890.77	5	846.23
Straight Pipes	14.30	100	0.00
Point Sources	18.90		18.90
Total	**9,167**	**27.8**	**6,616**

The allocation scenario for Stage 1 bacteria includes load reductions of 65% from direct deposition by livestock, 55% from pasture, 21% from cropland, 26% reduction from residential and urban sources, and 100% from straight pipes loads. The allocation scenario for Stage 2 requires increasing overall reductions of the residential and urban load to 86% and pasture load reductions to 87%. This final allocation scenario (Scenario 2 in 2006 TMDL study report, see page 25 in subject report) will result in no violations of the *E.coli* geometric mean criterion and less than 10.5% violations of the *E.coli* single sample maximum criterion. On attainment of these water quality milestones, Chestnut Creek would be delisted for *E.coli*.

The sediment allocation scenario for meeting the Chestnut Creek TMDL requires total load reductions of 1% from commercial and residential sources, 35% from pastureland, 29% from cropland, and 5% from streambank and channel erosion. These source reductions will result in a 27.8% overall reduction in sediment load which will meet TMDL.

Goals and Milestones

The ultimate goal of the Implementation Plan is to improve water quality in order to protect the use of Chestnut Creek for recreational activities such as swimming and aquatic life. The proposed timeline for achieving restored water quality in Chestnut Creek is twenty years with implementation actions divided into two ten-year stages. This staged approach concentrates early efforts on the most cost-efficient control measures and targets sources with the most interest from stakeholders.

Two types of milestones have been created for evaluating progress during each stage. Water quality milestones establish the goals for observing improvements in water quality while the implementation milestones outline the extent of BMPs to be installed. Generally, the Stage 1 water quality goal in bacteria TMDL implementation plans is based on reducing the number of violations of the single sample criterion to less than 10%; however, the TMDL study determined this goal would require reductions greater than 87% from land-based residential and agricultural bacteria loads. Thus, the Stage 1 water quality milestone in this implementation plan is to restore full support of the aquatic life use standard in Chestnut Creek. Stage 2 goals will result in Chestnut Creek being removed from the impaired water list due to fecal bacteria. This condition will meet Virginia's water quality standards for bacteria and allow for the delisting of Chestnut Creek from Virginia's 303(d) List of Impaired Waters.

Progress towards these goals can be assessed during the implementation process by tracking the development and execution of programs, policies, and practices (implementation actions) and through continued water quality monitoring. Improvements in water quality will be measured through monitoring of bacteria concentrations and the aquatic community throughout the watershed.

Implementation Actions

Potential control measures, their costs, and pollutant removal effectiveness estimates were identified through a review of the TMDL report, through input from the TMDL IP Working Groups, from a literature review, and from modeling. Because the TMDL watersheds contains a combination of residential and agricultural land uses, implementation actions to address the required pollutant reductions include a variety of control measures which target each pollutant source.

The quantity of corrective measures, or implementation actions, needed to meet the source final load reductions was determined through spatial analysis and the model used in the TMDL study. The recommended residential and urban management practices needed to attain the necessary reductions in both sediment and bacteria include

- pumping out 105 septic tanks,
- identifying and replacing 97 straight pipes,
- repairing 640 failing septic systems,

- replacing 576 failing septic systems with conventional septic systems
- replacing 62 failing septic systems with alternative on-site waste treatment systems,
- connecting 2 failing septic systems to public sewer,
- placing 3 pet waste stations in the watershed,
- implementing a pet waste education program,
- treating 18 acres with rain gardens, and
- installing 4.5 acres with riparian buffers.

The recommended agricultural management practices include

- installing 200 livestock exclusion systems,
- treating 11,615 acres of pasture with improved pasture management systems,
- reforesting 1,800 acres of erodible pasture,
- planting 95 acres of critical areas with permanent vegetative cover,
- installing 3 loafing lot management systems,
- installing 1 waste storage facility for beef cattle,
- installing water retention structures to treat 7,387 acres of pasture,
- applying continuous no-till to 8 acres,
- planting 206 acres of cover crop, and
- planting 2 acres of cropland with permanent vegetative cover.

In addition to these residential and agricultural practices, streambank stabilization practices should be installed on 1,985 linear feet of streams within the watershed to reduce the sediment load from streambank and channel erosion. Technical assistance will be needed to educate, design and install both residential and agricultural practices in the watershed. Additional outreach and education efforts will also be required to educate watershed residents about these practices.

Associated costs for each implementation action were estimated from the Virginia Department of Conservation and Recreation (VADCR) agricultural BMP database, from previous TMDL IPs, and from discussions with local stakeholders. The total estimated cost for implementation is $16,407,775.

Stakeholders and their Roles

Stakeholders are individuals who live or have land management responsibilities in the watershed, including private individuals, residential and agricultural landowners, government agencies, businesses, and special interest groups. Stakeholder participation and support is essential for achieving the goals of this TMDL effort (i.e., improving water quality and removing streams from the impaired waters list).

The Virginia Department of Environmental Quality (VADEQ) is the lead state agency in the TMDL process. VADEQ will continue monitoring in the watershed to evaluate water quality throughout the implementation period. The New River SWCD will provide cost-share funds, lead education and technical efforts, and track the agricultural and residential implementation practices. The USDA Natural Resources Conservation Service (NRCS) will also assist private landowners by providing funding through federal programs and offering technical assistance with installation of implementation practices.

Integration with Other Watershed Plans

Like most watersheds in Virginia, water quality improvements in the Chestnut Creek watershed are a component of many different organizations, programs and activities. Such efforts include, but are not limited to, watershed implementation plans, TMDLs, Roundtables, Water Quality Management Plans, Erosion and Sediment Control Regulations, Stormwater Management Programs, Source Water Assessment Programs, local comprehensive and strategic plans, and local environmentally-focused organizations. These efforts should be evaluated to determine their potential impacts on the implementation goals outlined in this clean-up plan. Often, these efforts are related or collaborative, but this is not always the case. Coordination of local programs can increase participation and prevent redundancy.

Potential Funding Sources

Funding sources that may be available to support implementation include:

- Federal
    - Clean Water Act 319 Incremental Funds
    - Conservation Reserve Program (CRP)
        - Conservation Reserve Enhancement Program (CREP)
    - Conservation Stewardship Program (CSP)
    - Environmental Quality Incentives Program (EQIP)
    - Agricultural Lands Easement Program
    - United States Fish and Wildlife Service grants
- State
    - Virginia Agricultural Best Management Practices (BMPs) Cost-Share Program
    - Virginia Agricultural Best Management Practices Loan Program
    - Virginia Agricultural Best Management Practices Tax Credit Program
    - Virginia Clean Water Revolving Loan Fund
    - Virginia Forest Stewardship Program
    - Virginia Outdoors Foundation and the Open Space Lands Preservation Trust Fund
    - Virginia Small Business Environmental Assistance Fund Loan Program
    - Virginia Stormwater Assistance Fund (SLAF)
    - Virginia Water Quality Improvement Fund (WQIF)
- Regional and Private Sources
    - Community Development Block Grants (CDBG)
    - National Fish and Wildlife Foundation
        - Five Star and Urban Waters Restoration Grant Program
    - Norcross Wildlife Foundation
    - Southeast Rural Community Assistance Project (SERCAP)
    - Virginia Environmental Endowment
    - Wetland and Stream Mitigation Banking

1. INTRODUCTION

1.1 Background

In 1972, the US Congress enacted the Federal Water Pollution Control Act known as the Clean Water Act (CWA). The founding objective of that legislation is well defined in its opening paragraph,

"to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

The legislation covers a range of water quality efforts aimed at reaching this objective. Immediately relevant to this project are the requirements that states develop and promulgate water quality standards for waters within their jurisdictions. In section 303(d) of the Act, the federal government requires states to identify those water bodies not meeting the published water quality standards for any given pollutant. This list is often called the "303(d) list" or the "impaired waters list." Virginia's first impaired waters list was published and reported to the United States Environmental Protection Agency (USEPA) in 1994. Recently, the 303(d) list has been combined with the 305(b) water quality assessment report which describes the overall quality of a state's waters. Virginia publishes and submits this "305(b)/303(d) Integrated Report" to USEPA every two years.

Section 303(d) requires that, if a particular water body is listed as "impaired," the state must develop a "total maximum daily load" for any pollutant that exceeds water quality standards in that water body. The "total maximum daily load" or TMDL is essentially a water pollution budget. A TMDL study defines the maximum amount of pollutant each source in the watershed can contribute to the water body, so that the water body remains in compliance with applicable water quality standards.

Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (WQMIRA) states in section 62.1-44.19:7 that the "Board shall develop and implement a plan to achieve fully supporting status for impaired waters." This means that after a TMDL is developed for an impaired water, an Implementation Plan (IP) must be developed and implemented with the goal of meeting the water quality standards for the water body. The IP presented in this document characterizes implementation actions that will achieve the water quality goals in Chestnut Creek.

1.2 Designated Uses

According to 9 VAC 25-260-5 of Virginia's State Water Control Board Water Quality Standards, the term 'water quality standards' means

> *"...provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law and the federal Clean Water Act."*

The 'Designation of Uses' of all waters in Virginia is defined in the Code of Virginia (9 VAC 25-260-10) (SWCB 2011):

All state waters, including wetlands, are designated for the following uses: recreational uses, e.g. swimming and boating; the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish.

Bacteria pollution is a serious threat to the uses of the state's waters for primary contact recreation such as swimming and boating. On August 8, 1994, the Virginia Department of Health (VDH) was notified that campers and counselors at a Shenandoah Valley summer camp developed severe gastrointestinal illness. It was confirmed that *E. coli* 0157:H7, a type of fecal bacteria commonly found in the intestines of humans and animals, was the causative agent (CDC 1995). In Franklin County, Virginia, a 1997 outbreak of illnesses involving three children was attributed to *E. coli* (0157:H7) in Smith Mountain Lake. The children came in contact with the bacteria while swimming in the lake, and a two-year-old child almost 2died as a result of the exposure (Roanoke Times 1997a, 1997b, 1998b). In August 1998, seven children and two adults at a day-care center in rural Floyd County were infected with *E. coli* (0157:H7). Upon investigation, two of the property's wells tested positive for total coliform (Roanoke Times 1998a, 1998c). On June 6, 2000, Crystal Spring (Roanoke, Virginia's second largest water source) was shut down by the VDH for *E. coli* contamination (Roanoke Times 2000).

These are not isolated cases. Throughout the United States, the Centers for Disease Control (CDC) estimates that at least 73,000 cases of illnesses and 61 deaths per year are caused by *E. coli* 0157:H7 bacteria (CDC 2001). Other fecal pathogens (*e.g., E. coli* 0111) are responsible for similar illnesses. In addition, the presence of other bacterial and viral pathogens is indicated by the presence of fecal bacteria. Whether the source of contamination is human or livestock waste, the threat of these pathogens appears more prevalent as both populations increase.

The General Standard is meant to protect the health of aquatic life, and also to serve as a fallback monitoring program to identify problems that are not detected by the ambient monitoring system (e.g., pollutant discharges that are intermittent in occurrence, isolated incidents of pollutant discharge, and discharge of pollutants that are not normally measured through the ambient monitoring system). The health of the aquatic life is measured through assessment of the benthic macroinvertebrate (benthic) community, which is integral to the food chain that supports higher-level organisms. An unhealthy aquatic community will impact local and downstream fisheries. Additionally, an aquatic community that is already impacted will not be a good indicator of pollutant problems in the stream. The specific pollutant being addressed for this General Standard TMDL Implementation Plan, sediment, is an indicator that soil is being lost from upland areas and/or stream banks. This should be a concern for landowners, who want to maintain the productivity of their land or protect their property from erosion.

1.3 Water Quality Standards and Criteria

The applicable water quality criteria for fecal bacteria impairments are contained in section 9 VAC 25-260-170. At the time the Chestnut Creek TMDL was completed, the criteria for bacteria included two parts: (1) the *Escherichia coli* (*E. coli*) bacteria concentrations for fresh water shall not exceed a geometric mean of 126 colony forming units (cfu) per 100 mL of water, and (2) the *E. coli* concentrations for freshwater shall not exceed 235 cfu per 100 mL at any time (single-sample criteria). If the water body exceeds the single sample maximum more than 10.5% of the

time, the water body is classified as impaired and a TMDL must be developed and implemented to bring the water body into compliance with the water quality standard. If the sampling frequency is one sample or less per 30 days, the single-sample criterion is applied; for a greater sampling frequency, the geometric mean criterion is applied. Most of the ambient water quality monitoring conducted by VADEQ is done on a monthly or bimonthly basis. This sampling frequency does not provide the two or more samples within 30 days needed for use of the geometric mean part of the standard. Therefore, VADEQ used the 235 per 100 mL part of the standard in the assessment of the *E. coli* bacteria monitoring data.

The **General Standard,** as defined in Virginia state law 9 VAC25-260-20, states:

> *A. All state waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.*

The General Standard is implemented by VADEQ through application of the Rapid Bioassessment Protocol II (RBP). Using the RBP, the health of the benthic macroinvertebrate community is typically assessed through the measurement of eight biometrics (Table 1-1). These biometrics gauge different aspects of the community's overall health. Surveys of the benthic macroinvertebrate community performed by VADEQ are assessed at the family taxonomic level.

Each biometric measured at a target station is compared to the same biometric measured at a reference (non-impaired) station to determine each biometric score. These scores are then summed and used to determine the overall bioassessment (e.g., non-impaired, moderately impaired, or severely impaired).

Table 1-1. Components of the RBP assessment.

Biometric	Benthic Health[1]
Taxa Richness	↑
Modified Family Biotic Index	↓
Scraper to Filtering Collector Ratio	↑
EPT / Chironomid Ratio	↑
% Contribution of Dominant Family	↓
EPT Index	↑
Community Loss Index	↓
Shredder to Total Ratio	↑

[1] An upward arrow indicates a positive response in benthic health when the associated biometric increases

2. STATE AND FEDERAL REQUIREMENTS FOR IMPLEMENTATION PLANS

2.1 Background

Once a water body is listed as impaired and a subsequent TMDL study has been conducted, then the state, in conjunction with watershed stakeholders, must develop and implement a strategy that will limit the pollutant loadings to those levels allocated in the TMDL. Such a strategy, also known as an Implementation Plan (IP), must contain corrective actions that when implemented will reduce pollutant loadings to bring the water body into compliance with the relevant standard(s).

2.2 State Requirements

The TMDL IP is a requirement of Virginia's 1997 Water Quality Monitoring, Information, and Restoration Act §62.1-44.19:4 through 19:8 of the Code of Virginia), or WQMIRA. WQMIRA directs the SWCB to "develop and implement a plan to achieve fully supporting status for impaired waters." In order for IPs to be approved by the Commonwealth, they must meet the requirements as outlined by WQMIRA. WQMIRA requires that IPs include the following:

- Date of expected achievement of water quality objectives,
- Measurable goals,
- Necessary corrective actions, and
- Associated costs, benefits, and environmental impact of addressing the impairment.

2.3 Federal Recommendations

Section 303(d) of the CWA and current USEPA regulations do not require the development of implementation strategies. The USEPA does, however, outline the minimum elements of an approvable IP in its 1999 *Guidance for Water Quality-Based Decisions: The TMDL Process. The listed elements include*

- A description of the implementation actions and management measures,
- A time line for implementing these measures,
- Legal or regulatory controls,
- The time required to attain water quality standards, and
- A monitoring plan and milestones for attaining water quality standards.

2.4 Requirements for Section 319 Fund Eligibility

Beyond the regulatory requirements listed above, the CWA was amended in 1987 to establish the Nonpoint Source (NPS) Management Program in Section 319 of that act. Through that program, States, Territories, and Native American Tribes can receive grant monies for a variety of activities, including the restoration of impaired stream segments. Although there are several sources of money to help with the TMDL implementation process, Section 319 funds are most relevant to TMDL implementation. Therefore, the requirements to obtain these funds are discussed in this chapter. The Virginia Department of Environmental Quality (VADEQ) strongly suggests that these USEPA recommendations be addressed in the IP (in addition to the required components as described by WQMIRA).

The USEPA develops guidelines that describe the process and criteria to be used to award CWA Section 319 NPS grants to States. The guidance is subject to revision and the most recent version should be considered for IP development. The "Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003" identifies the following nine elements that must be included in the IP to meet the 319 requirements:

1. Identify the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan;
2. Estimate the load reductions expected from NPS management measures;
3. Describe the NPS management measures that will need to be implemented to achieve the identified load reductions;
4. Estimate the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan;
5. Provide an information/education component that will be used to enhance public understanding of the project and encourage the public's participation in selecting, designing, and implementing NPS management measures;
6. Provide a schedule for implementing the NPS management measures identified in the watershed-based plan;
7. Describe interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented;
8. Identify a set of criteria for determining if load reductions are being achieved and progress is being made towards attaining water quality standards, and if not, the criteria for determining if the watershed-based plan needs to be revised; and
9. Establish a monitoring component to evaluate the effectiveness of the implementation efforts.

2.5 Staged Implementation

In general, the Commonwealth of Virginia intends for NPS pollutant TMDL reductions to be implemented in a staged or phased fashion. Staged implementation is an iterative process whereby management measures are implemented incrementally, initially targeting those sources and/or practices that are expected to produce the greatest water quality improvement. Staged implementation includes on-going monitoring to continuously assess progress toward attaining water quality standards. For example, a promising best management practice (BMP) in agricultural areas of a watershed with a bacteria impairment is livestock exclusion from streams. This has been shown to be very effective in lowering bacteria concentrations in streams, by reducing the opportunity for cattle to defecate directly in the stream and by providing additional buffering in the riparian zone. This practice has the additional benefit of reducing stream bank erosion.

There are many benefits of staged implementation, including:

1. tracking water quality improvements as they occur;
2. providing a measure of quality control, given the uncertainties that exist in any implementation plan;
3. providing a mechanism for developing public support;
4. helping to ensure the most cost-effective practices are implemented initially; and

5. allowing for the evaluation of the adequacy of the TMDL in achieving the water quality standard.

With successful development and implementation of IPs, Virginia will be well on the way to restoring impaired waters and enhancing the value of this important resource. Additionally, development of an approved IP will improve a locality's chances for obtaining monetary assistance during implementation.

3. REVIEW OF THE CHESTNUT CREEK TMDLS

3.1 Background

A TMDL is calculated as follows:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

where WLA is the waste load allocation (point sources), LA is the load allocation (nonpoint sources), and MOS is the margin of safety. A TMDL study determines the TMDL for the pollutant and, after accounting for MOS, allocates that loading between point sources (WLA) and nonpoint sources (LA).

This chapter reviews the development of the fecal bacteria TMDL and the sediment TMDL to address the benthic impairment along with the corresponding load allocations for Chestnut Creek. The TMDLs are described in the 2006 TMDL report: Total Maximum Daily Load Development, Fecal Bacteria and General Standard (Benthic).

3.2 Description of Impairments

As shown in Figure 3-1, Chestnut Creek is impaired for violations of the *E. coli* bacteria water quality standard from the confluence with Coal Creek to the New River confluence, and impaired for violations of the General Standard (benthic) from the Galax raw water intake to the confluence with New River. Chestnut Creek was first listed as impaired on Virginia's 1*996 303(d) Report on Impaired Waters* due to water quality violations of the General Standard (benthic). In addition, Chestnut Creek was listed as impaired due to violations of the State's water quality standard for bacteria in 2004.

3.3 Watershed Characteristics

The Chestnut Creek watershed (HUC 12 - 050500010603 and DEQ HUC listing code VAS-N06R) is located in Virginia's Carroll and Grayson counties, North Carolina's Surry and Alleghany counties, and the city of Galax, Virginia. It flows generally north to its confluence with the New River. The Chestnut Creek watershed comprises approximately 39,000 acres of land area with 7% characterized as developed, 36% agriculture and 57% forested according to the 2006 TMDL report (VADEQ 2006). Only 3.7% of the watershed is located in North Carolina. The 2006 TMDL report estimated a population of 11,137 in the watershed using US Census data.

3.4 Water Quality Monitoring

The bacteria TMDL was based on monitoring at four VADEQ in-stream water quality monitoring stations: 9-CST002.64, 9-CST010.45, 9-CST015.07, and 9-CST016.82 (Figure 3-2). Exceedances of the single sample maximum were reported throughout the monitoring period and in all flow regimes. Table 3-1 lists the stations, indicator organism, violation rate of appropriate water quality criterion, and the period of record.

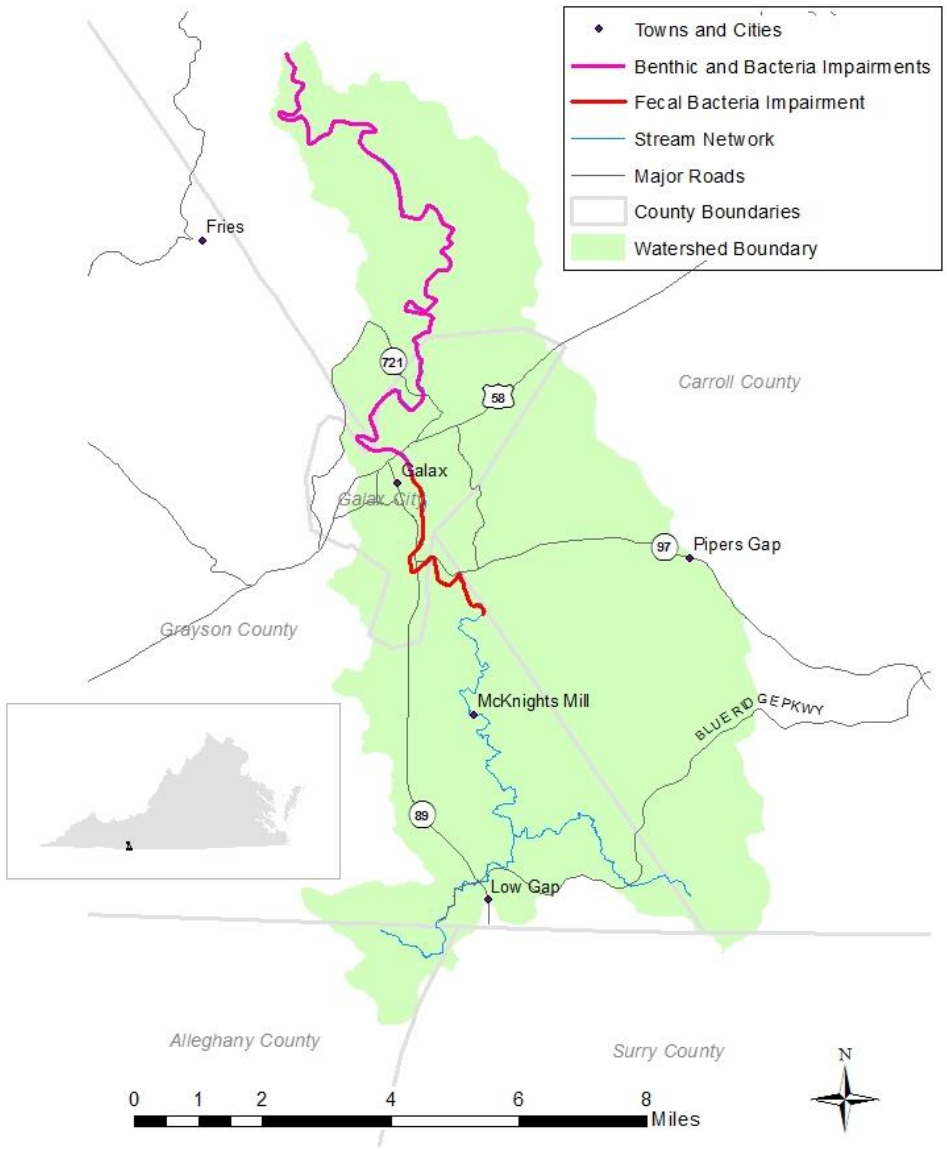

Figure 3-1. Location of the Chestnut Creek watershed and its impairments.

Table 3-1. Monitoring stations used to develop the bacteria TMDL for Chestnut Creek.

Station ID	Indicator Organism	# of Samples	Violations[1] (%)	Period of Record
9-CST002.64	Fecal coliform	186	37	Mar 1975 – Feb 2001
9-CST002.64	*E.coli*	4	25	Mar 2005 – Aug 2005
9-CST010.45	Fecal coliform	19	26	Jan 1990 – Oct 1991
9-CST015.07	Fecal coliform	11	45	May 1992 – May 1997
9-CST016.82	Fecal coliform	47	26	Aug 1996 – Apr 2005
9-CST016.82	*E.coli*	16	38	Jul 2002 – Aug 2005

[1] Violations are based on the fecal coliform instantaneous criterion (400 cfu/100mL) or the current *E. coli* single sample maximum criterion (235 cfu/100mL)

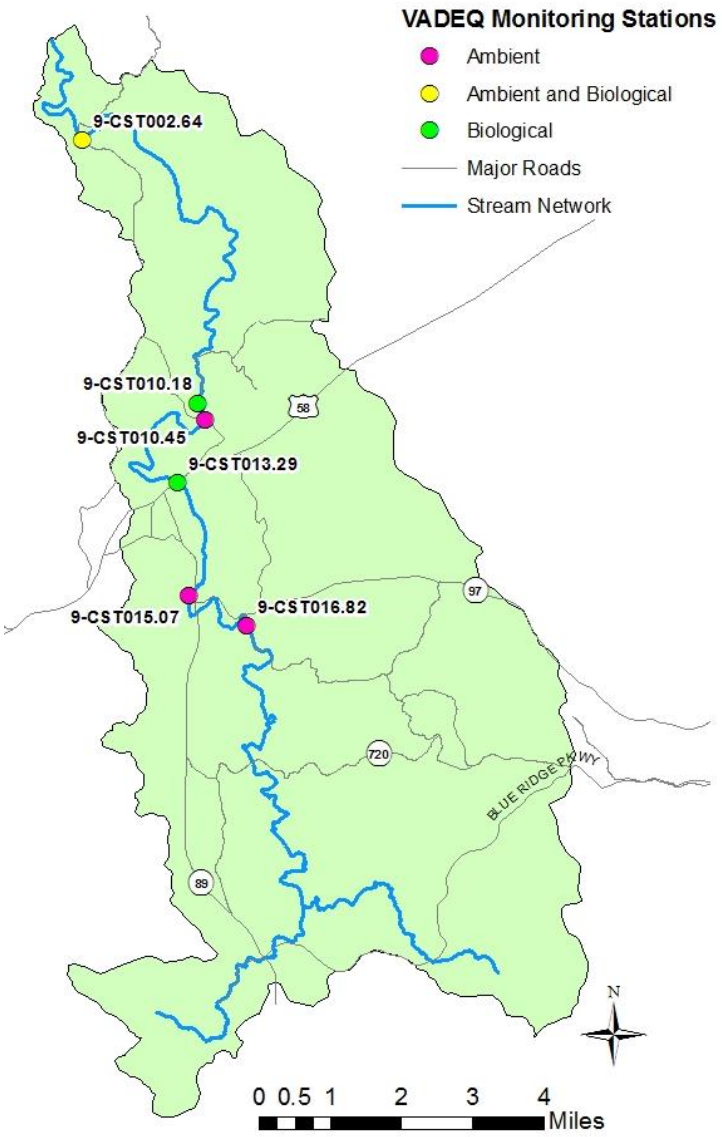

Figure 3-2. Location of VADEQ water quality monitoring stations used in the development of the Chestnut Creek TMDLs.

The benthic TMDL was based on monitoring conducted by VADEQ at three benthic monitoring stations: 9-CST002.64, 9-CST010.18, and 9-CST013.29. Chestnut Creek was first listed in 1996 as being impaired based on the Rapid Bioassessment Protocol II (RBP II) assessment method. The Virginia Stream Condition Index (VASCI) scores were calculated from the VADEQ benthic data (Table 3-2). Five of the seven scores for station 9-CST002.64 are below the impairment threshold of 61.3. Four out of eight scores are below 61.3 at station 9-CST010.18. All of the scores at station 9-CST013.29 are above the impairment threshold. Habitat assessments of Chestnut Creek considered in the TMDL report also indicated sub-optimal and marginal conditions with the primary problems being pool sediment and the lack of riparian vegetation (VADEQ, 2006).

Table 3-2. The VASCI biological monitoring scores used in the development of the Chestnut Creek benthic TMDL for sediment.

Station	Date	VASCI Score	Assessment
9-CST002.64	Dec 1992	61.64	Non-Impaired
	Nov 1993	53.84	Slightly Impaired
	Apr 1995	58.72	Slightly Impaired
	Jun 1997	47.71	Moderately Impaired
	Oct 2003	49.25	Moderately Impaired
	Jun 2004	63.50	Non-Impaired
	May 2005	55.66	Slightly Impaired
9-CST010.18	Dec 1992	53.68	Slightly Impaired
	Nov 1993	59.14	Slightly Impaired
	Apr 1995	62.44	Non-Impaired
	Jan 1996	63.48	Non-Impaired
	Jun 1997	54.50	Slightly Impaired
	Oct 2003	57.13	Slightly Impaired
	Jun 2004	66.29	Non-Impaired
	May 2005	67.13	Non-Impaired
9-CST013.29	Dec 1992	64.46	Non-Impaired
	Nov 1993	65.73	Non-Impaired
	May 2005	68.09	Non-Impaired

3.5 Water Quality Modeling

The US Geological Survey (USGS) Hydrologic Simulation Program - Fortran (HSPF) water quality model was selected as the modeling framework to simulate existing conditions and perform TMDL allocations for fecal coliform. In establishing the existing and allocation conditions, seasonal variations in hydrology, climatic conditions, and watershed activities were explicitly accounted for in the model. The Chestnut Creek model was calibrated for hydrologic accuracy using daily continuous stream flow data at USGS Station #03165000 on Chestnut Creek. For purposes of modeling watershed inputs to in-stream water quality, the Chestnut Creek drainage area was divided into nine sub-watersheds. The water quality calibration and validation were conducted using monitored data collected at VADEQ monitoring stations between October 1989 through September 1993 and from October 1998 through September 2002.

Virginia does not have existing in-stream criteria for sediment; therefore, a reference watershed approach was used to define allowable TMDL loading rates in the Chestnut Creek watershed. This approach pairs two watersheds: one that is supportive of their designated use(s) and one whose streams are impaired. The South Fork Holston River watershed was selected as the TMDL reference for Chestnut Creek. The TMDL sediment load was defined as the modeled sediment load for existing conditions from the non-impaired South Fork Holston River watershed, area-adjusted to the Chestnut Creek watershed. The Generalized Watershed Loading Function (GWLF) model (Haith et al. 1992) was used for comparative modeling for both Chestnut Creek and South Fork Holston River.

While developing allocation scenarios for bacteria, an implicit margin of safety (MOS) was used. Conservative assumptions, the use of a detailed watershed model (HSPF), and other

considerations were used in developing the bacteria TMDL, such that an explicit MOS was not necessary. In the sediment TMDL, the margin of safety was explicitly set to 10% to account for the large uncertainty in developing benthic TMDLs.

3.6 Sources of Bacteria

Potential sources of bacteria considered in the development of the TMDL included both point source and non-point source (NPS) contributions.

3.6.1 Point Sources

The TMDL WLA accounts for the portion of a receiving water's loading capacity that is allocated to one of its existing or future permitted point sources of pollution. Point sources of fecal coliform bacteria include all municipal and industrial plants that treat human waste and are issued individual permits by VADEQ, as well as private residences that fall under Virginia Pollutant Discharge Elimination System (VPDES) general permits. Point sources permitted to discharge in the Chestnut Creek watershed through the Virginia Pollutant Discharge Elimination System (VPDES) as of the 2006 TMDL are listed in Table 3-3. Galax WWTP (permit number VA0021075) historically discharged to Chestnut Creek, however the outfall was moved and it now discharges directly to the New River under permit number VA0078484.

Table 3-3. Permitted point sources in the Chestnut Creek watershed as identified in the TMDL report.

Facility	VPDES #	Design Discharge (MGD*)	Permitted for Fecal Control
Galax WTP	VA0052680	0.072	No
Honeywell – Gossan Mine Site	VA0082333	0.212	No
Galax WWTP	VA0021075 VA0078484	3.000	Yes
Domestic Sewage Discharge	VAG400062	0.001	Yes
Domestic Sewage Discharge	VAG400439	0.001	Yes
Vaughan Bassett Furniture Company	VAR050012	Stormwater	No
Vaughan Furniture Company, Inc. – B. C. Vaughan Plant	VAR050014	Stormwater	No
Vaughan Furniture Company, Inc. – E. C. Dodson Plant	VAR050015	Stormwater	No
Consolidated Glass & Mirror Corporation	VAR050019	Stormwater	No
National Textiles, Galax Plant	VAR050049	Stormwater	No
Webb Furniture Enterprises, Plant 1	VAR050099	Stormwater	No
Webb Furniture Enterprises, Plant 2	VAR050100	Stormwater	No
Webb Furniture Enterprises, Inc. - Particle	VAR050101	Stormwater	No
Rolling Frito Lay Sales LP - Galax Bins	VAR051557	Stormwater	No
Vaughan Furniture Company, Inc. - Corporate Offices	VAR100070	Stormwater	No
VDOT	VAR100556	Stormwater	No

*million gallons per day

3.6.2 Nonpoint Sources

Nonpoint source (NPS) pollution originates from diffuse sources on the landscape (e.g., agriculture and urban) and is strongly affected by precipitation events – runoff from rain or snowmelt. In some cases, a precipitation event is not required to deliver NPS pollution to a stream (e.g., direct deposition of fecal matter by wildlife or livestock and contamination from leaking sewer lines or straight pipes). NPSs were assessed during TMDL development through an extensive analysis of land use coupled with a consideration for delivery mechanisms (e.g., direct loadings to the stream or land-based loadings that require a precipitation event for delivery of the pollutants to the stream from pervious and impervious surfaces).

The TMDL report identified the primary nonpoint sources of bacteria in Chestnut Creek as agricultural runoff and failing septic systems (Table 3-4). Other sources of bacteria include direct deposition of livestock manure in streams, straight pipes, pet waste, and wildlife.

Table 3-4. Fecal bacteria sources in the Chestnut Creek watershed reported in the TMDL.

Source	Total Annual Loading for Existing Run ($x10^{10}$ cfu/yr)	% of Total Loading
Land Based		
Residential[1]	156,004	18.9%
Commercial	1,260	0.2%
Barren	15	<0.1%
Cropland	1,762	0.2%
Livestock Access	29,010	3.5%
Pasture	600,891	72.9%
Forest	31,230	3.8%
Direct		
Livestock Access	29	<0.1%
Wildlife	2,317	0.3%
Straight Pipes	1,729	0.2%
Total	**824,365**	

[1]Includes domestic animal populations which were estimated in 2006 as 2,883 dogs and 3,229 cats

3.7 Sources of Sediment

3.7.1 Stressor Analysis

TMDLs must be developed for a specific pollutant(s). Benthic assessments are very good at determining if a particular stream segment is impaired or not but, they usually do not provide enough information to determine the cause(s) of the impairment. The process outlined in the Stressor Identification Guidance Document (EPA 2000) was used to separately identify the most probable stressor(s) for Chestnut Creek. A list of candidate causes was developed from published literature and VADEQ staff input. Chemical and physical monitoring data provided evidence to support or eliminate potential stressors. Individual metrics for the biological and habitat

evaluation were used to determine if there were links to a specific stressor(s). Land use data as well as a visual assessment of conditions along the stream provided additional information to eliminate or support candidate stressors. This stressor analysis identified sediment as the Most Probable Stressor for aquatic life in Chestnut Creek.

3.7.2 Point Sources

There were two permitted domestic sewage treatment discharges, one industrial VPDES discharge, nine permitted industrial stormwater dischargers, and two permitted construction stormwater dischargers within the watershed at the time of TMDL development (Table 3-5). Permit number VA0021075 (Galax WWTP) discharged to Chestnut Creek until April 1990, then the outfall was moved to the New River. Permit number VA0052680 (Galax Water Treatment Plant) no longer discharges to Chestnut Creek.

Table 3-5. VPDES point source facilities and permitted TSS loads in the Chestnut Creek watershed.

Chestnut Creek Point Sources		**Existing Conditions**				**Future Conditions**
VPDES ID	Permit Discharge (MGD)	Runoff (cm)	Area (ha)	Conc. (mg/L)	TSS (tons/yr)	TSS (tons/yr)
VPDES Permits						
VA0082333	0.10			50	6.913	6.913
Residential Sewage Treatment Permits						
VAG400062	0.001			30	0.041	0.041
VAG400439	0.001			30	0.041	0.041
Construction Stormwater Discharge Permits						
VAR100070		16.492	3.618	100	0.597	0.597
VAR100556		16.492	2.355	100	0.388	0.388
Industrial Stormwater Discharge Permits						
VAR050012		38.483	0.526	100	0.202	0.202
VAR050014		38.483	12.141	100	4.672	4.672
VAR050015		38.483	1.133	100	0.436	0.436
VAR050019		38.483	7.649	0	0	0
VAR050049		38.483	7.123	100	2.741	2.741
VAR050099		38.483	4.128	100	1.589	1.589
VAR050100		38.483	2.550	100	0.981	0.981
VAR050101		38.483	0.769	100	0.296	0.296
VAR051557		0	0	0	0	0
Total Point Source Loads					**18.90**	**18.90**

3.7.3 Nonpoint Sources

Sediment is delivered to the Chestnut Creek watershed through surface runoff (rural and urban areas), streambank erosion, point sources, and natural erosive processes. The sediment process is a natural and continual process that is often accelerated by human activity. During runoff events (natural rainfall or irrigation), sediment is transported to streams from land areas (e.g., agricultural fields, lawns, forest, etc.). Rainfall energy, soil cover, soil characteristics, topography, and land management affect the magnitude of sediment loading. Agricultural management activities such as overgrazing (particularly on steep slopes), high tillage operations, livestock concentrations (along stream edge and uncontrolled access to streams), forest

harvesting, and construction (roads, buildings, etc.) accelerate erosion at varying degrees. During dry periods, sediment from air or traffic builds up on impervious areas and is transported to streams during runoff events.

The TMDL report identified the primary nonpoint sources of sediment in Chestnut Creek as pastureland, cropland and streambank erosion (Table 3-6).

Table 3-6. Future projected sediment loads for the Chestnut Creek watershed by land use (from the TMDL report).

Sediment Source	Area (acres)	Sediment (tons/yr)	Sediment (tons/acre)
VA Pervious Area:			
Commercial	445.1	11.75	0.026
Disturbed Forest	70.4	447.58	6.358
Forest	20,796.9	17.14	0.001
Wetland	30.9	0.02	0.001
Residential - Low Density	972.1	90.43	0.093
Pasture Improved	5,217.6	468.24	0.090
Pasture Unimproved	2,869.6	1,693.29	0.590
Pasture Overgrazed	2,348.0	3,379.47	1.439
Hay	2,694.0	193.27	0.072
Quarries	13.2	16.72	1.267
Row crop - High Till	270.7	1,100.09	4.064
Row crop - Low Till	343.6	564.46	1.643
Water	437.1	0	0.000
NC Pervious Area:			
Total	1,370.9	162.01	0.118
VA Impervious Area:			
Commercial	445.1	40.02	0.090
Residential - Low Density	648.1	58.03	0.090
NC Impervious Area:			
Total	3.8	0.32	0.084
Streambank Erosion		890.77	
Straight Pipes		14.30	
Point Sources		18.90	
Total	**38,977**	**9,167**	

3.8 TMDL Allocations and Load Reductions

3.8.1 Bacteria

Various pollutant reduction scenarios were evaluated to meet the state water quality standard for *E. coli*, the 30-day geometric mean target (126 cfu/100 mL), with zero violations (a requirement of the TMDL). An implicit MOS was used in these bacteria TMDLs by using conservative estimations of factors that would affect bacteria loadings in the watershed (e.g., animal numbers, production rates, contributions to the stream). These factors were estimated in such a way as to

represent the greatest amount of bacteria from each source in the watershed. The portion of *E. coli* that may come from permitted discharge sources was included in the Waste Load Allocation (WLA) and not given a load reduction during TMDL development. The WLA will be addressed through the Virginia Pollutant Discharge Elimination System (VPDES) Program administered by the Virginia Department of Environmental Quality.

The final allocation scenarios from the TMDL are shown in Table 3-7. Scenario 1 describes a baseline scenario that corresponds to the existing conditions in the watershed. Scenario 2 describes the Stage 1 implementation goal to reduce the bacteria loadings from controllable sources (excluding wildlife) such that violations of the single sample maximum criterion (235 cfu/100 mL) are less than 10.5 percent. Scenario 3 shows the final TMDL scenario.

Table 3-7. TMDL allocation scenarios for bacteria with 2006 loading estimates in the Chestnut Creek watershed.

	Percent Reduction in Loading from 2006 Condition						**Percent Violations**	
Scenario Number	Direct Wildlife	NPS Wildlife	Direct Livestock	NPS Agricultural	NPS Residential	Straight Pipe	GM >126 cfu/100ml	Single Sample >235 cfu/100ml
1	0	0	0	0	0	0	75.0	24.9
2	0	0	65	87	87	100	0.0	10.0
3	0	0	65	98	98	100	0.0	0.0

3.8.2 Sediment

The Chestnut Creek benthic TMDL was developed for sediment, with South Fork Holston River as the reference watershed. The target TMDL load for Chestnut Creek is the average annual load from the area-adjusted South Fork Holston River watershed under existing conditions. The benthic TMDL for Chestnut Creek includes three components – WLA, LA, and MOS. The margin of safety was explicitly set to 10% to account for uncertainty in developing benthic TMDLs. The WLA was calculated as the sum of the permitted point source loads.

The TMDL study anticipated that active development, including commercial, industrial and housing, would continue in the watershed over the next 20 years. Therefore, changes in land use were estimated by modeling future loads as part of the allocation process. The broad based land use change that was modeled resulted in 127 acres of forest and pasture land being converted to commercial, industrial, and residential areas. The reductions required to meet the TMDL considering future growth are shown in Table 3-8. Three sediment reduction alternatives were presented in the TMDL report and are listed in Table 3-9.

Table 3-8. Required sediment reductions for the Chestnut Creek watershed.

Load Summary	**Chestnut Creek (tons/yr)**	**Reductions Required**	
		tons/yr	**% of existing load**
Projected Future Load	9,167	2,551	27.8
TMDL	7,351		
Target Modeling Load	6,618		

Table 3-9. Source reductions needed to meet the sediment TMDL for Chestnut Creek.

Sediment Source	Future Sediment Load (tons/yr)	Scenario 1		Scenario 2		Scenario 3	
		Reductions (%)	Loads (tons/yr)	Reductions (%)	Loads (tons/yr)	Reductions (%)	Loads (tons/yr)
VA Pervious Area:							
Commercial	11.75		11.75		11.75		11.75
Disturbed Forest	447.58	34	295.40		447.58	39	273.03
Forest	17.14		17.14		17.14		17.14
Wetland	0.02		0.02		0.02		0.02
Residential - Low Density	90.43		90.43		90.43		90.43
Pasture Improved	468.24		468.24		468.24		468.24
Pasture Unimproved	1,693.29	33	1,134.50	40	1,015.97	39	1,032.91
Pasture Overgrazed	3,379.47	34	2,230.45	42	1,960.09	38	2,095.27
Hay	193.27		193.27		193.27		193.27
Quarries	16.72		16.72		16.72		16.72
Row crop - High Till	1,100.09	34	726.06	40	660.05	38	682.05
Row crop - Low Till	564.46		564.46		564.46		564.46
Water	0		0		0		0
NC Pervious Area:							
Total	162.01		162.01		162.01		162.01
VA Impervious Area:							
Commercial	40.02		40.02		40.02		40.02
Residential - Low Density	58.03		58.03		58.03		58.03
NC Impervious Area:							
Total	0.32		0.32		0.32		0.32
Streambank Erosion	890.77	34	587.91		890.77		890.77
Straight Pipes	14.30	100	0.00	100	0.00	100	0.00
Point Sources	18.90		18.90		18.90		18.90
Total	**9,167**	**27.8**	**6,616**		**6,616**		**6,615**

4. CHANGES AND PROGRESS SINCE THE TMDL STUDY

4.1 Land Use Changes

According to the TMDL report (VADEQ 2006), satellite images taken between 1990 and 1994 were used to identify the land use coverage in Chestnut Creek. A comparison of the land use area used in the TMDL study with more recent land use data from the 2011 National Land Cover Database (NLCD) shows that agricultural and forest land uses have decreased slightly and developed land use has increased. Table 4-1 lists the land use change estimates for the watershed. It was determined that the change in land use is consistent with the future land development considerations used to develop the TMDLs.

Table 4-1. Land use changes in the Chestnut Creek watershed.

Land Use	Chestnut Creek TMDL		2011 NLCD Land Use Layer	
	Acres	%	Acres	%
Virginia - Agriculture	13,741	35	13,657	35
Virginia - Developed	2,523	6	3,376	9
Virginia – Forest and Wetlands	20,893	54	20,124	52
North Carolina	1,375	4	1,375	4

4.2 Water Quality Monitoring

VADEQ has continued to assess water quality in Chestnut Creek since the development of the TMDL. Results of fecal bacteria monitoring since the TMDL study show that the stream is still impaired (Table 4-2).

Table 4-2. Recent *E. coli* monitoring results in Chestnut Creek and violation rates of the *E. coli* single sample maximum criterion.

Station ID	Stream Name	# of samples	Violation Rate	Sampling Period
9-CST002.64	Chestnut Creek	19	16%	12/2005-11/2010
9-CST016.82	Chestnut Creek	19	26%	9/2005-11/2008

Biological monitoring of the benthic macroinvertebrate community conducted by VADEQ since the development of the TMDL indicate that the aquatic life community in Chestnut Creek is improving. VADEQ's biological assessment method is based on the Virginia Stream Condition Index (VSCI) for Virginia's non-coastal areas (Tetra Tech, 2003). This multi-metric index is based on 8 biomonitoring metrics that are based on the diversity, pollution tolerance, and abundance of organisms identified during a taxa inventory of each sample. VSCI has a scoring range of 0-100, where a maximum score of 100 represents the best benthic community sites. The current threshold criteria defines "non-impaired" sites as those with a VSCI of 60 or above, and "impaired" sites as those with a score below 60. The VSCI scores for Chestnut Creek are shown in Figure 4-1. The VSCI scores for all three monitoring sites show improvements over time.

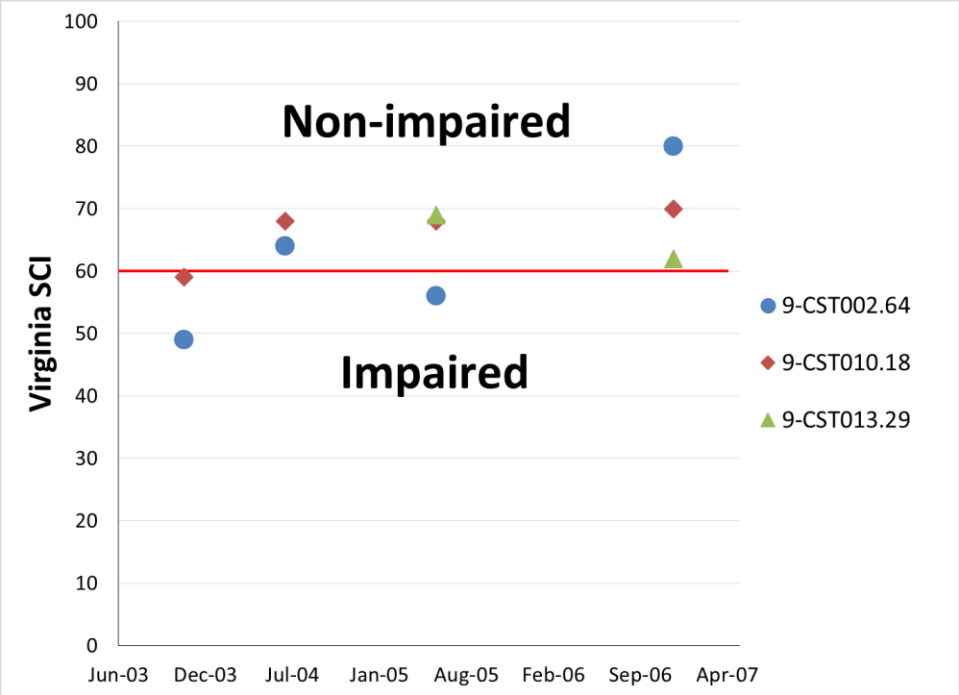

Figure 4-1. VSCI scores for Chestnut Creek (CST).

4.3 BMP Implementation

Since the 2006 TMDL, progress has been made in the Chestnut Creek watershed to reduce both bacteria and sediment pollution through the implementation of new BMPs (Table 4-3). Information on agricultural BMPs installed since 2006 was gathered from the Virginia Agricultural Cost Share Tracking Program and represents BMPs implemented since 2006 that have also received cost-share funding. It does not represent additional agricultural BMPs that landowners have decided to implement voluntarily without participation in a state and/or federally sponsored cost-share program. In addition to agricultural BMPs, the City of Galax is managing stormwater runoff within the City as required by Virginia's mandatory stormwater regulations, and the City is constantly working on upgrades of the City's sewer systems.

Table 4-3. BMPs installed in the Chestnut Creek watershed since TMDL development.

BMP Name	BMP Code	Extent Installed	
		Units	Amount
CREP grazing land protection	CRSL-6	linear feet	17,422
CREP riparian forest buffer planting	CRFR-3	acres	34
Extension of CREP watering systems	SL-7	acres	56
Livestock exclusion with reduced setback	LE-2	linear feet	886
Permanent vegetative cover on critical areas	SL-11	acres	5
Permanent vegetative cover on cropland	SL-1	acres	72
Protective cover for specialty crops	SL-8	acres	136
Small grain cover crop for nutrient management	SL-8B	acres	1,721
Stream exclusion with grazing land management	SL-6	linear feet	28,727

4.4 Modifications to the Sediment Allocation Scenario

During implementation planning, the recommended percent reductions from each sediment source in the allocation scenario changed slightly from the TMDL study. BMPs installed since the TMDL study and the reductions needed to meet the bacteria water quality goals were considered when selecting the final allocation scenario for the sediment TMDL. Table 4-4 describes the allocation scenario used to develop the TMDL implementation plan.

Table 4-4. Source reductions needed to meet the sediment TMDL for Chestnut Creek.

Sediment Source	Future Sediment Load (tons/yr)	Allocation Scenario	
		Reductions (%)	Loads (tons/yr)
VA Pervious Area:			
Commercial and Residential	102.18	1	101.16
Disturbed Forest	447.58		447.58
Forest	17.14		17.14
Wetland	0.02		0.02
Pasture	5,541.00	36	3,545.76
Hay	193.27		193.27
Quarries	16.72		16.72
Row crop	1,664.55	30	1,166.63
Water	0		0
NC Pervious Area:			
Total	162.01		162.01
VA Impervious Area:			
Commercial and Residential	98.05	1	97.07
NC Impervious Area:			
Total	0.32		0.32
Streambank Erosion	890.77	5	846.23
Straight Pipes	14.30	100	0.00
Point Sources	18.90		18.90
Total	**9,167**	**27.9**	**6,613**

5. PUBLIC PARTICIPATION

An essential step in crafting a TMDL implementation plan and then implementing that plan is input from and engagement of a broad range of stakeholders (individuals, agencies, organizations, and businesses who have an interest in improving water quality and a familiarity with local conditions). Public participation involves a dialogue between local stakeholders and government agencies and a discussion of available resources that can be devoted to TMDL implementation, such as funding and technical support. This collaborative process also helped build understanding and trust among participants who need to maintain close working relationships in order to meet the plan's water quality goals. Public participation occurred via a series of public meetings (Table 5-1).

Table 5-1. Schedule of meetings held during the development of the Chestnut Creek IP.

Meeting Date	Meeting Type	# of Attendees
September 23, 2014	Kickoff Public Meeting, Working Group	12
November 19, 2014	Agricultural, Residential, and Government Working Group	14
April 7, 2015	Steering Committee	13
May 26, 2015	Final Public Meeting	13

The first public meeting was held on the evening of September 23, 2014 at the Department of Forestry Office in Galax to kick off the development of the implementation plan. The meeting was publicized through a press release published in local papers, email announcements, and flyers posted throughout the watersheds. Approximately 12 people attended the meeting. The meeting served as an opportunity for local residents to learn about water quality in Chestnut Creek, become familiar with the TMDL and clean-up process, and provide feedback on local watershed concerns and opportunities.

A government, agricultural and residential working group was formed to discuss implementation and outreach strategies suitable for different land uses in the watershed. The working group consisted of stakeholders who were familiar with land use management issues in the specific focus areas. The working group met on September 23, 2014 following the Kickoff Public Meeting to focus on agricultural and residential issues.

A working group meeting was held on November 19, 2014 at the Galax Recreation Center. During this meeting the residential, agricultural, and government working group was able to discuss relevant topics and provide or verify estimates for model parameter. First, the group reviewed conservation practices and outreach strategies from an agricultural perspective. The group discussed changes that may have occurred in the watershed since the TMDL was published in 2006. Suspected changes included land cover/land use, number of cattle, and new BMPs implemented in the watershed. Much of the conversation focused on livestock exclusion practices, including how to best contact potential participants. Additional BMPs considered for the Chestnut Creek watershed included municipal stormwater, and riparian buffer width. The stakeholders also noted that only one dairy is located in the watershed and that the IP could credit the City of Galax and landowners for BMPs implemented during the period between the TMDL and the IP.

Next, the working group identified strategies to reduce bacteria from human sources and pet waste as well as to reduce sediment from residential and urban settings. The group talked about known stormwater and wastewater issues within the City of Galax and work being done by the City to address these issues. They emphasized stream stabilization as a way to address stormwater scour and flooding issues. The group agreed that 97 straight pipes seemed high for the area and discussed ways to educate the public about a residential septic program.

Also at the November meeting, the focus on government issues led to a conversation about water quality in the Chestnut Creek watershed between local governments, regional organizations and representatives of state and federal agencies. Representatives from Galax discussed flooding issues and agreed stream stabilization could be an effective and popular strategy to decrease flooding in the City. The group reviewed conservation practices and outreach strategies as well as identified technical and financial resources needed to carry out implementation. They discussed septic systems and straight pipes at length, specifically barriers to reaching potential participants and strategies for fine-tuning the estimates for both numbers and practices needed to address the problem. The group also discussed the timeline for funding, potential for delisting Chestnut Creek and alleviating bacterial impairment, and the potential for bringing new customers to existing sewer lines.

The Steering Committee met on April 7 to discuss plans for a final meeting and to review a draft of the implementation plan. A final public meeting was held on May 26 at the Galax Recreation Center in Galax.

6. IMPLEMENTATION MEASURES

An important element of the TMDL implementation plan is to encourage voluntary implementation of control measures designed to reduce pollutant loads. To assist voluntary implementation, information must be obtained on the types of control measures that can achieve the pollutant reduction goals specified in the TMDL as practically and cost-effectively as possible. In other words, control measures that provide "the biggest bang for the buck" are targeted.

6.1 Selection of Practices

While management actions such as livestock exclusion and replacement of straight pipes reduce the direct loads to the stream described in the TMDL, a number of additional measures are needed to control bacteria and sediment coming from land-based sources. Various scenarios were developed and presented to the working groups, who reviewed both the economic costs and the water quality benefits. The majority of agricultural BMPs in this plan are included in state and federal agricultural cost share programs that promote conservation. In addition, innovative management practices suggested by local producers and technical conservation staff were considered. The final set of practices identified and the efficiencies used in this study are listed in Appendix A. It should be noted that an adaptive management strategy will be utilized in the implementation of this plan. BMPs that are easiest to implement, provide the greatest water quality benefits, and offer the greatest economic return to landowners will be implemented first. The effectiveness of these practices will be continually evaluated, and adjustments of actions will be made as appropriate. As new technologies and innovative BMPs to address bacteria and sediment become available, these practices should also be evaluated for implementation in the watershed.

6.2 Straight Pipes and Failing Septic Systems

Septic systems can be a safe and effective method for treating domestic wastewater as long as they are sized, sited and properly maintained. A number of factors can cause septic systems to fail, including unsuitable soil conditions, improper design and installation, and inadequate maintenance (EPA 2014). In some cases, wastewater illegally discharges from homes directly to streams or the land surface through what is known as a "straight pipe". Spillage of human waste from straight pipes and failing septic systems into streams can have a variety of negative effects including the spread of diseases which make waterways unsafe for recreation. State laws require both failing septic systems and straight pipes be corrected once identified which translates to a 100% reduction in bacteria from these sources.

Table 6-1 shows the estimated number of households in the Chestnut Creek watershed with failing septic systems and straight pipes as identified in the TMDL report. The failing septic system estimate factored in the age of homes in the watershed, and in the case of straight pipes, the proximity of homes to streams. The TMDL projected the number of households in the watershed to 2005 based on the Carroll and Grayson Counties growth rates which resulted in 2,620 septic systems. During IP development, 2010 Census data (USCB 2010) and information on the sewer network provided by the City of Galax were used to estimate current population, household and septic system numbers within the watershed. It was determined that the population, the total number of households, and the estimated number of households on septic systems appears to be comparable to the 2005 estimate included in the TMDL study.

Table 6-1. Estimated failing septic systems, straight pipes and residential practices needed in the Chestnut Creek watershed.

Failing Septic Systems	Straight Pipes	Pump-outs	Connection to Sewer	Repairs	Septic System Replacements	Alternative Waste Treatment Systems
1,280	97	105	2	640	663	72

Practices for treating failing septic systems and straight pipes were chosen based on input from the local Virginia Health Department staff and stakeholders as well as research from previous IPs. Based on existing conditions in the watershed, it was estimated that 90% of straight pipes would require installation of a conventional septic system and 10% with an alternative waste treatment system. Fifty percent of failing septic systems would require repairs and 50% would require replacements: 45% with a conventional system, 4.8% with an alternative waste treatment system, and 0.2% with a connection to public sewer.

Stakeholders identified septic system pump-outs as a practice to offer residents as an educational tool and as a way to further identify failing systems. This program could receive cost-share funding as an incentive for homeowner participation; it could also target homeowners closest to identified streams or those with financial burdens. The number of pump outs listed in Table 6-1 was calculated as 4% of the 2006 estimate of households in the watershed with septic systems. Stakeholders also identified the cost of connecting to sewer as a practice that could be bolstered by the availability of cost-share funding. Based on feedback, it was estimated that 2 failing septic systems in the City of Galax could be replaced by connections to public sewer.

6.4 Pet Waste

Studies show that approximately 60-70% of pet owners claim to clean up after their dogs most or all of the time while the remaining 30-40% rarely or never pick up their dog's waste (Hardwick 1997). Left on the ground, pet waste can easily be washed by runoff into storm drains or nearby waterbodies. Pet waste not only carries bacteria, viruses, and parasites that can threaten the health of humans and wildlife, but it can also deposit nutrients that promote algal growth. Studies show that up to 95% of fecal matter could potentially be eliminated from an urban watershed if all dog owners simply picked up after their pets (Alderserio et al. 1996; Trail et al. 1993).

A pet waste education program increases public awareness about these water quality issues and encourages pet owners to properly dispose of their pet's waste at home and in public dog walking areas. A fully implemented pet waste education program will include the development and distribution of educational materials, installation of pet waste stations in key locations (two in City parks and one on the New River Trail State Park), and the promotion of other pet waste BMPs such as pet waste digesters or composters. The installation of the three pet waste stations will include signage, disposal bags, and a waste receptacle to dispose of pet waste.

The City of Galax already has signage in City parks and a City Code requiring pet owners to clean up after their pets. Any waste left by the animal must be collected immediately. The addition of a pet waste education program will be a reasonable next step in reducing pet waste from entering Chestnut Creek.

6.5 Urban and Residential Stormwater

Impervious surfaces (roads, parking lots, and sidewalks) are made from materials that unlike soil prevent water from percolating down into the ground. During storms, these surfaces carry the water, along with any materials (bacteria, sediment, trash, fertilizers, etc.) it picks up along the way, to storm drains and nearby waterbodies. Measure known as BMPs or stormwater treatment practices (STPs), mitigate these impacts by storing and filtering runoff before it can affect downstream water bodies. The Chestnut Creek watershed needs BMPs that address both stormwater quality and quantity in order to reduce urban bacteria and sediment loads. In Virginia, local jurisdictions, like the City of Galax, are the primary provider of stormwater services, but these practices can and should be applied to any developed area in the watershed needing stormwater control.

Urban stormwater BMPs are diverse and continuing to grow. Ultimately, BMP selection for a specific site will depend upon its physical and financial feasibility as well as other factors such as pollutant removal efficiency, maintenance needs, aesthetics, and wildlife habitat function. This IP includes a selection of potential BMPs based on their common usage, high cost-effectiveness, and stakeholder feedback. Stormwater BMPs considered in this plan include riparian buffers and rain gardens (bioretention filters). Potential projects are identified in Table 6-2.

Table 6-2. Urban and residential stormwater BMPs.

BMP	Units	Extent
Rain gardens	acres treated	18
Riparian buffers	acres-installed	4.5

6.5.1 Low Impact Development (LID) BMPs

Low impact development (LID) is about managing rainfall at the source using smaller-scale controls rather than the traditional method of channeling stormwater through pipes to large-scale holding areas. LID mimics natural hydrology by allowing rainwater to infiltrate, filter, evaporate, and accumulate at the source. These types of control measures should be considered because they are flexible and can easily be integrated into urban sites. LID techniques also tend to cost less to construct because they require less grey infrastructure than traditional, conventional stormwater controls.

Rain gardens are landscaped gardens of trees, shrubs, and plants located in commercial or residential areas in order to treat stormwater runoff through temporary collection of the water before infiltration. They are slightly depressed areas into which stormwater runoff is channeled by pipes, curb openings, or gravity.

Riparian buffers contain vegetation that physically separates a waterbody from surrounding development. Buffers can provide economic, environmental, recreational, and aesthetic value to a community. They preserve the floodplain, encourage infiltration, filter pollutants, capture sediment, provide wildlife habitat, and regulate water temperature.

Other examples of LID include vegetated roofs, permeable pavement and pavers, rain barrels, and rain gutter disconnects.

6.5.2 Pollution Prevention/Good Housekeeping

In addition to structural BMPs, local municipalities can implement or enhance certain activities to address the impacts of stormwater on bacteria and sediment loads in Chestnut Creek. Over time, streets and parking lots accumulate pollutants including sediment, debris, trash, road salt, and even waste that can be carried by runoff to nearby surface waters. Street sweeping can minimize these loads while also improving roadway aesthetics. The effectiveness of a street sweeping program will depend upon the equipment, its operation and maintenance, sweeping schedule, waste storage and disposal. Bacteria and sediment loads may be reduced further by the regular cleaning of storm drain systems

All localities are required by law to develop a program to reduce pollutants in stormwater runoff from construction sites disturbing one or more acres. These programs generally begin with an ordinance that requires the implementation of erosion and sediment BMPs as well as procedures for reviewing site plans, responding to public concerns, site inspections, and enforcement. Programs must meet the minimum standards set forth in the Virginia Erosion and Sediment Control Law, Regulations, and Certification Regulations (effective July 1, 2013), but Enhanced Erosion and Sediment Controls may be an option for permittees in watersheds with known sediment issues to reduce their loads. Municipalities can "enhance" their program several ways such as designating a smaller threshold for construction sites requiring E&S plans, mandating faster site stabilization, adding staff to ensure proper enforcement of existing program components, and increasing the frequency of inspections in watersheds with sediment impaired streams. (Clark et al. 2014).

6.5.3 Green Infrastructure

In addition to small-scale structural BMPs, urban stormwater could potentially be addressed through the development of green infrastructure. Green infrastructure is both the interconnected green space network managed for its natural resource values and the process of promoting systematic and strategic land conservation for the good of nature and people. The scale of green infrastructure ranges from small urban rain gardens to greenways to large tracts of undeveloped land. Green infrastructure can address several different water issues including stormwater management, flood mitigation, and water quality. For example, Milwaukee, Wisconsin developed a conservation plan for important floodplain areas to complement traditional stormwater management techniques and improve water quality (Benedict and McMahon 2006). Local efforts to create walking paths, trails, and greenways could also expand to include conservation corridors and the protection of water resources.

6.6 Streambank and Channel Erosion

Streambank erosion is a natural process, but alterations to the stream system can greatly accelerate the process resulting in erosion rates far greater than those typically seen. Channel erosion is estimated to contribute about 10% of the sediment reaching Chestnut Creek from nonpoint sources, making streambank stabilization efforts critical. Significant reductions could be made through the implementation of improved stormwater management in urban areas, installation of riparian buffers throughout the watershed, and livestock exclusion from streams. However, additional stream mitigation will be needed to meet the in-stream channel erosion reductions identified in the Chestnut Creek TMDL. The total stream restoration length necessary to achieve the sediment load reductions was calculated as **1,985 linear feet**.

Due to the variability in streambank form and needs, streambank stabilization and restoration techniques must be selected on a site-by-site basis. Resource needs will depend on the specific technique(s), ranging from low tech, landowner friendly projects (live plantings) to relatively high-cost designs requiring professional design services (channel re-shaping). The 2004 Virginia Stream Restoration and Stabilization Best Management Practices Guide provides an in-depth review of the permitting issues, planning and design principles, costs, and best management practices associated with stream restoration projects (VADCR 2004).

6.7 Direct Deposition

When livestock, especially cattle, have uncontrolled access to streams, they often deposit their feces nearby or directly into the stream. Their waste contains fecal bacteria, an indicator of other disease-causing bacteria that can harm human health. Additionally, the livestock tend to congregate around the water source, trampling the stream banks and overgrazing the riparian vegetation which further contributes to stream sedimentation issues. The 2006 TMDL study specified a 65% reduction in the direct deposition of waste into the stream by livestock. This will be accomplished by limiting livestock access to streams with fencing and providing alternative water sources.

A GIS analysis of hydrologic and land use data was conducted to assess potential fencing needs in the watershed. Perennial and intermittent stream segments flowing through pastureland were identified and evaluated against aerial imagery to detect land uses categorized as pasture but serving an alternative purpose (i.e. golf course). Fencing lengths were calculated for both sides of a stream segment if it flowed through identified pastureland and only for one side if it flowed adjacent to pasture and another land use. While not every pasture has grazing livestock at every single point in time, it was assumed that all pasture areas have the potential for livestock access. Stream feet within pasture, current fencing extent, and estimated stream exclusion fencing needs on perennial streams are listed in Table 6-3.

Table 6-3. Stream exclusion fencing needs assessment.

	Linear Feet	Linear Miles
Total potential fencing	437,773	83
Perennial	*182,216*	*35*
Intermittent	*255,557*	*48*
Fencing installed to date	53,003	10
Fencing installed before TMDL study	*5,968*	*1*
Fencing installed since TMDL study	*47,035*	*9*
Remaining fencing needed (65% livestock exclusion)	233,638	44

Landowners have a growing number of cost-share options for livestock exclusion fencing systems. The most common resources for fencing systems in Virginia are the state Agricultural BMP Cost-share program administered by local Soil and Water Conservation Districts (SWCDs) and the National Resource Conservation Service (NRCS) cost-share program. The most applicable cost-share BMPs for livestock exclusion in the Chestnut Creek watershed are the SL-

6T/SL-6 (stream exclusion with grazing land management), LE-1T (Livestock Exclusion with Riparian Buffers for TMDL Implementation), LE-2T (Livestock Exclusion with Reduced Setback for TMDL Implementation), WP-2T (Stream Protection for TMDL Implementation), and the Conservation Reserve Enhancement Program (CREP) stream exclusion practice (CRSL-6). Technical specifications and cost-share rates vary by practice as shown in Table 6-4. Local District, NRCS, and Farm Service Agency (FSA) personnel provided feedback on the typical distribution of systems among the available cost-share practices as well as the average cost of systems associated with the different practices. Data was also pulled from the VADCR BMP Cost-share database for comparison to these estimates and to help account for the fencing systems put into place in the watershed since the 2006 TMDL. Based on data from the VADCR Agricultural BMP database, 47,035 feet of stream exclusion fencing has been implemented in the Chestnut Creek watershed since 2006 (see Table 4-3).

Table 6-4. Comparison of cost-share programs available for livestock exclusion practices.

Practice Code	Required Buffer Distance (feet)	Components Eligible for Cost-share Payment				
		Permanent Stream Crossing	Cross Fencing	Alternate Water Supply	Restricted Crossing	Hardened Access or Crossing
SL-6T/SL-6	35	X	X	X	X	
LE-1T	35	X	X	X	X	
LE-2T	10	X	X	X	X	
WP-2T	35	X				X
CRSL-6	35	X		X	X	

If a landowner can afford to give up 35 feet for a buffer along the stream, then they are eligible to receive cost share at a rate of 75% to 85% to cover the costs of the stream fencing, cross fencing and providing alternative water. Based on stakeholder input, it is estimated that 70% of the total fencing in the watersheds will be installed using this particular practice (codes LE-1T and SL-6T/SL-6). Farmers who cannot afford to give up 35 feet or more for a streamside buffer can receive 50% cost share for the installation of exclusion fencing with a ten foot setback, cross fencing, and to provide an alternative water source for their livestock. It is estimated that 20% of total fencing in the watersheds will be installed using this practice (code LE-2T). In cases where a watering system already exists, a WP-2T system is a more appropriate choice. This system includes streamside fencing and a 35-ft buffer from the stream. This practice includes an up-front cost share payment of 50 cents per linear foot of fence installed to assist in covering fencing maintenance costs. Since financial assistance with development of alternative water sources is a significant incentive for farmers to install fencing, this practice is used infrequently because it does not provide cost share for the installation of a well. Consequently, it was estimated that only 5% of fencing in the watersheds would be accomplished using this practice. For those who are willing to install a 35 foot buffer or larger and plant trees in the buffer, the Conservation Reserve Enhancement Program (CREP) is an excellent option. This practice provides cost share and incentive payments ranging from 50% to 115% for fencing, planting materials, and alternative water source development (code CRSL-6). It is estimated that 5% of fencing in the watersheds will be installed through this program. Table 6-5 shows the fencing required for the impaired watershed in order to meet the livestock exclusion goal.

Table 6-5. Livestock exclusion BMPs (feet and number of exclusion systems).

LE-1T/SL-6T/SL-6		LE-2T		WP-2T		CREP	
Feet	**# Systems**	**Feet**	**# Systems**	**Feet**	**# Systems**	**Feet**	**# Systems**
163,546	149	46,728	39	11,682	7	11,682	5

6.8 Pastureland

Pasture lands provide forage for grazing by domestic livestock, commodities which contribute largely to Virginia's economic prosperity (VDACS 2015). Improper pastureland management can lead to soil compaction and overgrazing which encourage erosion and runoff. Grazing animals deposit manure on any available pastureland, but waste tends to be most concentrated near feeding and watering areas. Poorly located or managed areas can quickly become barren, increasing the possibility of contaminated runoff (Alderfer and Robinson 1947). Pasture runoff carries both bacteria from the livestock waste and sediment from the eroding soils to nearby streams. Pastureland BMPs can greatly reduce these pollutant loads as well as improve overall pastureland production.

Improved pasture management through the implementation of a prescribed grazing system can prevent overgrazing by livestock, thereby reducing runoff, increasing filtration and vegetative uptake of pollutants, and allowing farmers to better utilize their pasture acreage. This practice includes: maintaining minimum forage height during the growing season, application of lime and fertilizer when needed, following a nutrient management plan, controlling woody vegetation, distributing manure through managed rotational grazing, a sacrifice area for feeding during winter and summer droughts, and reseeding if necessary.

Farmers can utilize state and federal cost share programs to convert highly erodible pasture such as areas with steep slopes and poor vegetative cover to forest. These types of pasture typically produce a lower yield of forage for livestock making them less optimal for grazing or cutting hay. In addition, establishing permanent vegetation on small degraded sites with excessive erosion will stabilize the area and protect water quality by reducing bacteria and sediment runoff.

Additional structural practices, such as animal waste control facilities that temporarily store beef cattle manure give producers greater control of when and where manure nutrients are spread, reduce the chance for manure to contaminate water sources. Loafing lot management systems prevent manure and sediment runoff from areas exposed to heavy livestock traffic from entering nearby water corridors and streams. Water retention structures such as erosion control dams, desilting reservoirs, or sediment basins have the capacity to treat large volumes of runoff before it enters the stream.

During the working group meetings, local stakeholders estimated that thirty acres of erodible pasture could be converted to forest each year of implementation and permanent vegetation could be established on ten acres of critical area per year. Improved pasture management was prescribed to the remaining pasture acreage. Stakeholders also estimated that there is opportunity to construct one waste storage facility for beef cattle and three loafing lot improvements in the watershed. The remaining bacteria reductions needed to meet the water quality goals were quantified as acres-treated by water retention structures. Table 6-6 shows pasture BMPs needed

in order to reduce bacteria and sediment to a level at which the streams can be removed from the impaired waters list.

Table 6-6. Pasture BMPs for Chestnut Creek watershed.

BMP	Units	Extent Required
Improved Pasture Management	acres	11,615
Reforestation of Erodible Pasture	acres	1,800
Permanent Vegetative Cover on Critical Areas	acres	95
Loafing Lot Management	system	3
Waste Storage Facility (beef)	system	1
Water Retention Structures	acres-treated	7,233

6.9 Cropland

When exposed to rainfall, cropland fertilized with manure may contribute additional bacteria and sediment to runoff. Filtering practices such as riparian buffers can help trap those pollutants before they reach local streams. Reducing soil tillage, increasing soil organic content, and improving soil cover can also help reduce the amount of runoff and soil loss during rain events. Certain practices may also help reduce the levels of bacteria in the manure prior to application such as increasing storage times and during application by reducing manure use.

Many farmers in the Chestnut Creek watershed are already using some form of reduced tillage and cover crops on cropland as confirmed by the New River SWCD. While a few of these cropland and other agricultural practices are documented in the VADCR Cost-share database, other practices are not included because they are undertaken voluntarily by the producers. Thus, Agricultural Working Group members helped establish some baseline estimates for the watershed. In preparing this plan, it was estimated that 45% of cropland currently employs cover crops and less than 30% of cropland is currently in high tillage.

Farmers till their land to aerate, warm, and shape soil as well as to bury crop residue and remove weeds. Beyond these benefits though, tilling results in many other negative effects like soil compaction, loss of organic matter, disruption of soil organisms, and increased soil erosion and runoff. No-till farming, in contrast, minimizes soil disruption, but requires different management techniques to maintain crop yields. The Continuous No-Till System practice (SL-15A) provides a per-acre payment for farmers who stop tilling their soil.

Although cover crops have been used by farmers for centuries, the practice had recently been replaced by the widespread increase in fertilizer and herbicide use. Farmers are generally moving back toward the use of cover crops because of the benefits associated with improved soil quality, enhanced fertility, decreased field maintenance, and erosion control. Two types of cover cropping practices were selected for this plan. The protective cover for specialty cropland practice (SL-8) and the small grain cover crop practice (SL-8B) were selected because they provides cost-share and tax credits to participating farmers for establishing vegetative cover, specifically grains like winter rye and winter wheat, on cropland for protection from erosion and the reduction of nutrient losses to groundwater (VACS 2015).

Local stakeholders identified a small number of cropland areas that could benefit from continued installation of the permanent vegetative cover on cropland practice (SL-1). Establishing permanent vegetation on small degraded sites with excessive erosion will stabilize the areas and protect water quality by reducing bacteria and sediment runoff. Table 6-7 shows the estimated extent of cropland BMPs needed in order to remove the streams from the impaired waters list.

Table 6-7. Cropland BMPs for Chestnut Creek watershed.

BMP	Units	Extent Required
Continuous No-till	acres	8
Protective Cover for Specialty Cropland	acres	14
Small Grain Cover Crop	acres	192
Permanent Vegetative Cover on Cropland	acres	2

6.10 Technical Assistance

The implementation plan will require the involvement of many landowners throughout the watershed, many of which will have no prior knowledge of water quality issues and BMPs. A survey of producers by the National Institute of Food and Agriculture found the most effective educational programs required dedicated personnel, a resource currently in decline (Luloff et al. 2012). Individuals are needed to help identify, educate and involve landowners as well as help design and install the actual BMPs. Therefore, technical assistance resources are a key component of this clean-up plan.

Technical Assistance Tasks

- Assist in and approve design of BMPs for residential and/or agricultural land uses
- Locate funding to finance implementation practices
- Inspect completed cost-share practices and document site visits
- Verify landowner match requirement
- Complete paperwork for cost-share payments
- Track and report practice implementation
- Educate and provide outreach to the general public about the implementation plan and other ways to improve local water quality

The staffing level needed to implement the agricultural and residential components of the plan was estimated based on discussions with stakeholders and the staffing levels used in similar projects. Staffing needs were quantified using full time equivalents (FTE), with one FTE being equal to one full-time staff member. It was determined that 1.5 FTEs would be needed to provide the technical assistance needed for agricultural and residential BMPs over two stages of implementation, with each stage covering a ten year period. Should funding become available, the New River SWCD could house an agricultural technician to manage outreach and technical assistance with design and implementation of agricultural BMPs. The position of a residential coordinator to conduct outreach and work with landowners to address failing septic systems, straight pipes, pet waste, residential stormwater, and stream restoration could also be housed at the New River SWCD.

6.11 Education and Outreach

In order to get landowners involved in implementation, it will be necessary to initiate education and outreach strategies and provide technical assistance with the design and installation of various best management practices. There must be a proactive approach to contact farmers and residents to identify the practices that will help meet the goal of improved water quality while also meeting their needs as private landowners. Economic costs and benefits must be considered in this process. The working group recommended several education/outreach techniques, which can be utilized during implementation.

The following tasks associated with outreach programs were identified:

Agricultural Programs

- Make contact with landowners in the watersheds to make them aware of implementation goals, cost-share assistance, and voluntary options that are available to agricultural producers interested in conservation
- Provide technical assistance for agricultural programs (e.g., survey, design, layout)
- Develop and distribute educational materials through bulk mailings, Galax Farmers Market, Carroll County Fair, Grayson County Youth Livestock Show, local businesses (e.g., Southern States, Galax Farm Supply), Grayson-Carroll Farm Service Agency (FSA) and Virginia Cooperative Extension (VCE) newsletters, etc.
- Organize educational programs (e.g., farm tours, presentations at VCE events or club events)

Residential Programs

- Identify straight pipes and failing septic systems (e.g., contact landowners in older homes near the streams, septic pump-out program)
- Develop and distribute educational materials (e.g., septic system maintenance guide, pet waste disposal brochure)
- Organize educational programs (e.g., demonstration septic pump-outs, pet waste control)
- Partner with VCE's Master Gardeners of the Blue Ridge to provide educational programs targeted to reduce residential stormwater (e.g., rain gardens, stream restoration)

7. IMPLEMENTATION COSTS

7.1 Residential BMP Costs

The total cost for residential septic system, straight pipe, and pet waste practices totals $6,689,500 as shown in Table 7-1. The costs for residential practices were estimated using input from local Virginia Department of Health (VDH) staff and the New River SWCD as well as information from other recent TMDL Implementation Plans in Virginia. These costs are shown with the VADEQ TMDL BMP cost-share codes included.

Table 7-1. Estimated residential BMPs and costs.

Control Measure	BMP Code	Units	Unit Cost	Total	Total Cost
Failing Septic Systems					
Septic Tank Pump-out	RB-1	system	$300	105	$31,500
Connection to Public Sewer	RB-2	system	$5,000	2	$10,000
Septic Tank System Repair	RB-3	system	$3,500	640	$2,240,000
Septic Tank System Installation/Replacement	RB-4/ RB-4P	system	$5,000	576	$2,880,000
Alternative On-site Waste Treatment System	RB-5	system	$15,000	62	$930,000
Straight Pipes					
Septic Tank System Installation/Replacement	RB-4/ RB-4P	system	$5,000	87	$435,000
Alternative On-site Waste Treatment System	RB-5	system	$15,000	10	$150,000
Pet Waste Management					
Pet Waste Stations[1]		system	$3,000	3	$9,000
Pet Waste Education Program		program	$4,000	1	$4,000
Total Estimated Cost					**$6,689,500**

[1] Unit cost based on purchasing system as well as the estimated cost of trash can liners, waste bags, and maintenance for 10 years

The number of pet waste stations needed was estimated by analyzing the number of parks and miles of trails within the watershed. Three key locations were identified for the installation of pet waste stations, two in City parks and one on the New River Trail State Park. Over a lifespan of 10 years, each pet waste station will cost about $3,000 considering the cost of the station hardware, waste can liners, waste bag refills, and maintenance.

A Pet Waste Education program for the watershed would cost approximately $4,000. This would cover the cost of outreach efforts to educate landowners about this particular water quality issue. Lack of knowledge of the connection between pet waste and water quality issues has been recognized as one of the main barriers in getting pet owners to clean up their dog's waste (Syferd 1995). Outreach efforts may include creating and distributing flyers, posters, waste bag samples, advertisements, and display materials.

7.2 Stormwater BMP Costs

Stormwater BMP cost estimates were developed using stakeholder input, information from other recent Implementation Plans and other available literature. The estimated total cost for stormwater BMPs is $92,250. Table 7-2 lists the urban and residential stormwater BMPs and their associated costs. Stormwater BMPs installed during Stage 1 will meet the TMDL sediment reduction goal from residential and urban sources.

Table 7-2. Urban and residential stormwater BMPs and costs.

BMP	Units	Unit Cost	Total Units	Total Cost
Rain Gardens	acres treated	$5,000	18	$90,000
Riparian Buffers	acres installed	$500	4.5	$2,250
Total Estimated Cost				**$92,250**

7.3 Streambank Stabilization BMP Costs

Streambank stabilization estimates shown in Table 7-3 were based on similar watershed clean-up plans and input from the Chestnut Creek working groups. The estimated total cost for streambank stabilization efforts is $595,500. All streambank stabilization practices have been prioritized for implementation during the first stage of work based on stakeholder feedback. Streambank stabilization practices are applicable to all land uses in the watershed. More complex stream restoration projects would be applicable in the watershed to support sediment reduction efforts and stakeholders estimated the cost of full stream channel restoration at $200-$300 per linear foot. However, the increased unit cost may result in a greater sediment removal rate than just basic stabilization efforts, making restoration projects a potentially cost-effective option.

Table 7-3. Streambank stabilization estimates for the Chestnut Creek watershed.

Control Measure	Unit	Unit Cost	Units Needed	Total Cost
Streambank Stabilization	linear ft.	$300	1,985	$595,500

7.4 Agricultural BMP Costs

The total cost of agricultural BMPs needed in the Chestnut Creek watershed to meet the delisting goal is $7,230,525. This includes $4,725,000 for practices to address direct deposition through livestock exclusion systems, $2,499,865 for pastureland practices, and $5,660 for cropland practices. Costs associated with each of the agricultural BMPs needed in the watershed were estimated using data from the VA Agricultural BMP Tracking Program and feedback from New River SWCD and NRCS staff. The majority of recommended practices are eligible for state and federal cost share programs. These programs offer landowners financial assistance for implementing practices and may include with some practices incentive payments to further encourage participation. The per system costs shown for each practice in Table 7-4 include the total practice cost which is comprised of both the expected cost share payment and the landowner's cost responsibility. These costs are shown with VADCR and VADEQ TMDL BMP cost-share codes included.

Table 7-4. Estimated agricultural BMPs and costs.

Control Measure	BMP Code	Units	Average Unit Cost	Total Units	Costs
Livestock Exclusion					
Livestock Exclusion with Riparian Buffers	CRSL-6	system	$30,000	5	$150,000
	SL-6, SL-6T, LE-1T	system	$25,000	149	$3,725,000
Livestock Exclusion with Reduced Setback	LE-2T	system	$20,000	39	$780,000
Stream Protection System	WP-2T	system	$10,000	7	$70,000
Pasture					
Improved Pasture Management	SL-7T, SL-9, SL-10T	acres	$75	11,615	$871,125
Reforestation of Erodible Pasture	FR-1	acres	$120	1,801	$216,120
Permanent Vegetative Cover on Critical Areas	SL-11	acres	$2,000	95	$190,000
Loafing Lot Management System	WP-4B	system	$20,000	3	$60,000
Animal Waste Control Facility	WP-4	system	$150,000	1	$150,000
Sediment Retention, Erosion or Water Control Structures	WP-1	acres-treated	$140	7,233	$1,012,620
Cropland					
Continuous No-till	SL-15A	acres	$20	8	$160
Protective Cover for Specialty Cropland	SL-8	acres	$25	14	$350
Small Grain Cover Crop	SL-8B	acres	$25	192	$4,800
Permanent Vegetative Cover on Cropland	SL-1	acres	$175	2	$350
Total Estimated Cost					**$7,230,525**

The total cost of livestock exclusion systems includes not only the costs associated with fence installation and maintenance, but also the cost of developing alternative water sources for SL-6, SL-6T, LE-1T, LE-2T, and CREP practices. It should be noted that CREP does not pay for cross fencing to establish a rotational grazing system; however, this program is commonly combined with state funded practices such as SL-7T to help cover these costs. Financial assistance with maintaining fences is available through the WP-2T practice which includes an upfront incentive payment of $0.50 per linear foot. However, this practice has not been used in the watershed since it does not provide cost share for alternative water systems. A state tax credit of 25% for stream fencing maintenance costs is available through the state cost-share program (practice code WP-2D).

7.5 Technical Assistance Costs

Technical Assistance costs were based on the types and extent of practices included in the Implementation Plan. It was estimated that one full-time equivalent (FTE) position would be needed for the agricultural practices and ½ FTE would be needed for the residential/urban practices (Table 7-6). A cost estimate of $60,000 per year per full-time position was used based on existing staffing costs included in the Virginia Department of Conservation and Recreation's grant agreements with the Soil and Water Conservation Districts across the state to provide technical assistance to landowners in TMDL implementation watersheds. Based on the twenty year timeline of this plan (described in detail in the Measurable Goals and Milestones section of this plan), 1.5 full time positions are needed for two stages each covering 10 years, making the total cost of technical assistance approximately $1,800,000.

7.6 Total Implementation Cost

Implementation of the measures outlined in this plan will occur in stages. Implementation of practices included in Stage 1 is expected to result in meeting the sediment TMDL goal and full support of the aquatic life use standard in Chestnut Creek. Stage 2 includes additional practices needed to reduce bacteria to a level at which Chestnut Creek can be removed from Virginia's impaired waters list. The staged implementation is described in more detail in the Measurable Goals and Milestones section.

In total, it is estimated that it will cost about $16.4M to remove Chestnut Creek from the impaired waters list (Table 7-5). These costs are broken down into the two stages of implementation as well as into five basic categories: residential, stormwater, streambank stabilization, agricultural, and technical assistance.

Table 7-5. Total estimated cost for the Chestnut Creek Implementation Plan.

	Residential BMPs	Stormwater BMPs	Stream Stabilization BMPs	Agricultural BMPs	Technical Assistance	Total
Stage 1	$2,441,500	$92,250	$595,500	$5,826,705	$900,000	$9,855,955
Stage 2	$4,248,000	-	-	$1,403,820	$900,000	$6,551,820
Total	**$6,689,500**	**$92,250**	**$595,500**	**$7,230,525**	**$1,800,000**	**$16,407,775**

8. IMPLEMENTATION BENEFITS

The ultimate goal of this clean-up plan is to meet water quality standards in Chestnut Creek that support human recreational use and the propagation of aquatic life. Reducing bacteria and sediment loads in Chestnut Creek will protect human health and safety, promote healthy aquatic communities, improve agricultural production, and add to the economic vitality of the community.

8.1 Human Health and Safety

Human, livestock, and wildlife waste can carry viruses and bacteria that are harmful to human health. Throughout the United States, the Centers for Disease Control (CDC) estimates that at least 73,000 cases of illnesses and 61 deaths per year are caused by *E. coli* 0157:H7 bacteria (CDC, 2001). Other fecal pathogens (*e.g., E. coli* 0111) are responsible for similar illnesses. Reducing the presence of bacteria in the watershed should considerably reduce the chances of infection from E. coli sources through contact with Chestnut Creek's surface waters. In addition to preventing infection and disease, strategies in this plan addressing stormwater could help mitigate and prevent future flooding.

8.2 Healthy Aquatic Communities

Excessive sediment can smother a stream by killing aquatic flora and clogging the spaces in between river bed substrate that usually provide habitat for benthic macroinvertebrates (Harrison et al. 2007). Accumulation of sediment may also lead to changes in the composition of the benthic macroinvertebrate community, favoring tolerant taxa over intolerant types. These "bugs" are often a major food source for many species of freshwater fish and a decrease in their availability can ripple up the food chain. Thus, the health of the whole aquatic ecosystem is dependent in part upon its physical habitat.

Reducing sediment in the Chestnut Creek watershed will help restore the health of aquatic communities for the benefit of the flora, fauna and human residents. For example, streamside buffers will help reduce erosion and provide shade for fisheries which will in turn provide more stock for local anglers. In 2011 alone, approximately $3.5 billion was spent on wildlife recreation in Virginia (USDOI et al. 2011). Buffers can also improve habitat for wildlife that also benefit from having access to a healthy, thriving aquatic community.

8.3 Agricultural Production

This plan recognizes that each and every farmer faces their own unique management challenges. Thus, some of the BMPs in this plan may be more suitable and more cost-effective for one landowner than for another in the watershed. Similarly, the benefits of implementing these practices will vary, but can be estimated based on general research.

Restricting cattle access to streams and providing them with a clean water source can improve weight gain and milk production (Zeckoski et al. 2007; Landefeld et al. 2002). Increasing weight as well as milk and butterfat production can translate into economic gains for producers as shown in Table 8-1 (Zeckoski et al. 2007). Additionally, keeping cattle in clean, dry areas has been shown to reduce the occurrence of mastitis and foot rot. The Virginia Cooperative Extension estimates mastitis costs producers $150 per cow in reduced milk production quantity and quality (Jones and Balley 2009).

Table 8-1. Production gains associated with provision of clean water for dairy cattle (Surber et al., 2005).

Typical calf sale weight	Additional weight gain with access to clean water	Price	Increased revenue
500 lb/calf	5% (25lb)	$0.60/lb	$15/calf

Note: Table from Zeckoski et al. (2007)

8.4 Community Economic Vitality

Healthy watersheds provide many ecosystem services necessary for a community's well-being. These services include, but are not limited to, water filtration and storage, air filtration, carbon storage, energy, nutrient cycling, removal of pollutants, soil formation, recreation, food and timber. Many of these services are hard to quantify in terms of dollars and are often under-valued (Bockstael et al. 2000). However, it is understood that many of these services are difficult to replace and often expensive to artificially engineer. Efforts to restore the Chestnut Creek watershed to a healthier state will reduce the financial burden on residents, businesses, and municipalities who currently bear the cost of damages caused by a degraded aquatic system such as flooding. Stormwater infrastructure that keeps stormwater runoff onsite can reduce losses from flood damage by $6,700-$9,700 per acre (Medina et al. 2011.) Urban stormwater BMPs can also help increase stormwater retention and lower peak discharges, thereby reducing the pressure on and need for stormwater infrastructure. This will in turn lower engineering, land acquisition, and material costs for municipalities and private enterprises.

Once the IP is complete, organizations in the watershed will be eligible to apply for competitive funding to help cover some of the costs associated with installing the BMPs. These potential funds along with matching funds from other sources will benefit many local contractors involved in the repair and installation of septic systems, building of fencing systems, and installation of stormwater structures. In a 2009 study, researchers estimated that every $1 million invested in environmental efforts such as reforestation, land and watershed restoration, and sustainable forest management, would create approximately 39 jobs (Heintz et al. 2009).

Individual homeowners and residents could also see financial benefits from these efforts. Implementation activities in the plan will help give homeowners the knowledge and tools needed for extending the life of their septic systems. The overall cost of ownership could also be reduced by advocating regular pump outs which cost about $300 compared to the $3,500-$15,000 cost of a repair or replacement system. The additional services provided by new stormwater BMPs could raise the market value of nearby homes 0-5% (Braden and Johnston 2004). Another study in the Chesapeake Bay area found that lower fecal coliform concentrations correlates with increased property values (Leggett and Bockstael 2000).

9. GOALS AND MILESTONES

9.1. Implementation Goals

The goals of TMDL implementation are to restore the water quality in the impaired stream segments in the Chestnut Creek watershed so that they comply with water quality standards and to de-list Chestnut Creek from the Commonwealth of Virginia's 303(d) List of Impaired Waters. Progress towards these goals can be assessed during the implementation process by tracking the number/type of control measures that are installed and programs or policies developed and executed (implementation actions) and continued water quality monitoring. Improvements in water quality will be measured through monitoring of bacteria concentrations and quality of the aquatic life community throughout Chestnut Creek.

9.2. Implementation Milestones and Water Quality Goals

The implementation of control measures will be accomplished in stages. In general, the Commonwealth intends that the needed control measures be implemented in a progressive process that first addresses the pollutant sources with the largest impact on water quality. Based on input from the working group regarding BMP adoption rates, the proposed timeline for achieving restored water quality in Chestnut Creek has been divided into two stages with each stage spanning a period of ten years. This staged approach concentrates early efforts on the most cost-efficient control measures and sources with the most interest from stakeholders. For example, the TMDL study indicated that over 75% of the total estimated bacteria and sediment loads in Chestnut Creek are from agricultural sources. Concentrating resources on livestock exclusion fencing systems and pasture management practices within the first several years may provide the highest return on water quality improvement with the least cost to landowners.

The benefits of staged implementation are 1) as stream monitoring continues, it allows for water quality improvements to be recorded as they are being achieved; 2) it provides a measure of quality control, given the uncertainties which exist in any implementation plan; 3) it provides a mechanism for developing public support; 4) it helps to ensure that the most cost-effective practices are implemented initially; and 5) it allows for the evaluation of the adequacy of the TMDL in achieving the water quality standard.

Two types of milestones will be used to evaluate progress over the 20 year period: *implementation milestones* and *water quality milestones*. The implementation milestones establish goals for the extent of the different best management practices installed within certain time frames, while the water quality milestones establish the corresponding goals for improvements in water quality.

Implementation of practices included in Stage 1 is expected to result in full support of the aquatic life use standard in Chestnut Creek. Stage 2 goals will result in Chestnut Creek being removed from the impaired water list due to fecal bacteria. Tables 9-1 and 9-2 show the water quality improvement goals, and costs in each implementation stage. Table 9-3 shows the implementation milestones in two-year increments for each stage.

Greater reductions in non-point source pollution would be needed in order to achieve the final TMDL with 0% violations of both the single sample and geometric mean *E. coli* standards. However, this would require a 98% reduction from all non-point source loads from agricultural

and residential areas. Therefore, this implementation plan focuses on the practices in which anthropogenic sources of bacteria are addressed to the maximum extent practicable, based on stakeholder input and conclusions from other bacteria implementations plans developed in Virginia, to remove Chestnut Creek from the impaired waters list.

Table 9-1. Practices needed to meet bacteria and sediment milestones in Stage 1.

BMP Type	BMP	Units	Extent	Cost
Direct Deposition	Livestock Exclusion with Riparian Buffers	system	154	$3,875,000
	Livestock Exclusion with Reduced Setback	system	39	$780,000
	Stream Protection System	system	7	$70,000
Pasture	Improved Pasture Management	acres	11,615	$871,125
	Reforestation of Erodible Pasture	acres	291	$34,920
	Permanent Vegetative Cover on Critical Areas	acres	95	$190,000
	Loafing Lot Management	system	-	-
	Animal Waste Control Facility	system	-	-
	Water Control Structures	acres-treated	-	-
Cropland	Continuous No-till	acres	8	$160
	Harvestable Cover Crop	acres	14	$350
	Small Grain Cover Crop	acres	192	$4,800
	Permanent Vegetative Cover on Cropland	acres	2	$350
Streambank Stabilization	Streambank Stabilization	feet	1,985	$595,500
Pet Waste	Pet Waste Education Program	program	1	$4,000
	Pet Waste Stations	system	3	$22,500
Septic	Septic Tank Pump-out	system	105	$31,500
	Connection to Public Sewer	system	2	$10,000
	Septic Tank System Repair	system	192	$672,000
	Septic Tank System Installation/Replacement	system	259	$1,295,000
	Alternative On-site Waste Treatment System	system	28	$420,000
Urban Stormwater	Rain Gardens	acres-treated	18	$90,000
	Riparian Buffer	acres-installed	4.5	$2,250
Average annual *E. coli* load (cfu/yr) (Existing = 8.25 x 10^{15} cfu/yr)				**1.74 x 10^{14}**
% Violation of Single Sample *E. coli* criterion (235 cfu/100mL) (Existing = 24%)				**20.40**
% Violation of Geometric mean *E. coli* criterion (126 cfu/100mL) (Existing = 81%)				**29.6**
Average annual sediment load (T/yr) (Existing = 9,167) (TMDL goal = 6,616)				**6,613**
% Reduction in sediment load (TMDL goal = 28%)				**28**
Total Cost for Stage 1 (including Technical Assistance)				**$9,855,955**

Table 9-2. Practices needed to meet bacteria and sediment milestones in Stage 2

BMP Type	BMP	Units	Extent	Cost
Direct Deposition	Livestock Exclusion with Riparian Buffers	system	-	-
	Livestock Exclusion with Reduced Setback	system	-	-
	Stream Protection System	system	-	-
Pasture	Improved Pasture Management	acres	-	-
	Reforestation of Erodible Pasture	acres	1,510	$181,200
	Permanent Vegetative Cover on Critical Areas	acres	-	-
	Loafing Lot Management	system	3	$60,000
	Animal Waste Control Facility	system	1	$150,000
	Water Control Structures	acres-treated	7,233	$1,012,620
Cropland	Continuous No-till	acres	-	-
	Harvestable Cover Crop	acres	-	-
	Small Grain Cover Crop	acres	-	-
	Permanent Vegetative Cover on Cropland	acres	-	-
Streambank Stabilization	Streambank stabilization	feet	-	-
Pet Waste	Pet Waste Education Program	program	-	-
	Pet Waste Stations	system	-	-
Septic	Septic Tank Pump-out	system	-	-
	Connection to Public Sewer	system	-	-
	Septic Tank System Repair	system	448	$1,568,000
	Septic Tank System Installation/Replacement	system	404	$2,020,000
	Alternative On-site Waste Treatment System	system	44	$660,000
Urban Stormwater	Rain Gardens	acres-treated	-	-
	Riparian Buffer	acres-installed	-	-
Average annual *E. coli* load (cfu/yr)				**6.47×10^{13}**
% Violation of Single Sample *E. coli* criterion (235 cfu/100mL)				**10.34**
% Violation of Geometric mean *E. coli* criterion (126 cfu/100mL)				**0**
Average annual sediment load (T/yr) (TMDL goal = 6,618)				**3,732**
% Reduction in sediment load (TMDL goal = 28%)				**59**
Total Cost for Stage 2 (including Technical Assistance)				**$6,551,820**

Table 9-3. Implementation milestones at two-year increments.

Control Measure	Units	Stage 1					Stage 2				
		Yrs 1-2	Yrs 3-4	Yrs 5-6	Yrs 7-8	Yrs 9-10	Yrs 11-12	Yrs 13-14	Yrs 15-16	Yrs 17-18	Yrs 19-20
Livestock Exclusion with Riparian Buffers	system	42	31	31	26	24	-	-	-	-	-
Livestock Exclusion with Reduced Setback	system	6	6	9	9	9	-	-	-	-	-
Stream Protection System	system	3	1	1	1	1	-	-	-	-	-
Improved Pasture Management System	acres	4,000	3,000	1,800	1,800	1,015	-	-	-	-	-
Reforestation of Erodible Pasture	acres	60	60	60	60	51	80	80	80	500	670
Permanent Vegetative Cover on Critical Areas	acres	20	20	20	20	15	20	20	20	20	20
Continuous No-till	acres	5	3	-	-	-	-	-	-	-	-
Cover Crop	acres	50	40	40	40	36	-	-	-	-	-
Permanent Vegetative Cover on Cropland	acres	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-
Loafing Lot Management	system	-	-	-	-	-	1	1	1	-	-
Waste Storage Facility (beef)	system	-	-	-	-	-	-	-	-	1	-
Water Retention Structures	acres-treated	-	-	-	-	-	1,100	1,100	1,100	1,900	2,033
Streambank Stabilization	linear feet	397	397	397	397	397	-	-	-	-	-
Septic Tank Pump-out	system	21	21	21	21	21	-	-	-	-	-
Connection to Public Sewer	system	1	1	-	-	-					
Septic Tank System Repair	system	39	39	38	38	38	90	90	90	89	89
Septic Tank System Installation/Replacement	system	52	52	52	52	51	81	81	81	81	80
Alternative On-site Waste Treatment System	system	6	6	6	5	5	9	9	9	9	8
Pet Waste Education Program	number	---------- 1 ----------					-	-	-	-	-
Pet Waste Stations	number	3	-	-	-	-	-	-	-	-	-
Rain Gardens	acres-treated	4	4	4	3	3	-	-	-	-	-
Urban Riparian Buffers	acres-installed	1	1	1	1	0.5	-	-	-	-	-

9.3 Reasonable Assurance

Public participation is an integral part of the IP development and is critical in gaining support for both the voluntary implementation activities that are being planned. During the public participation process, the major stakeholders in the watershed and a wide variety of local

conservation agency personnel were involved in public meetings and working groups. They also provided additional information through in-person, email and phone conversations. This participation by the major watershed stakeholders provides a reasonable assurance that the public was contributing to the TMDL process and had input into the selection of management and implementation practices recommended by this IP.

Efforts to address the bacteria and aquatic life (benthic) impairments in Chestnut Creek will be carried out primarily through the use of voluntary BMPs and education targeting nonpoint sources. Available cost-share programs will be utilized to the greatest extent possible to provide positive incentives to watershed stakeholders. Conservation technicians are already on staff at the New River SWCD to assist producers in implementing agricultural BMPs. The Steering Committee is encouraged to seek grant funding to provide additional monies to increase participation from stakeholders that would otherwise be reticent to participate.

Taken together, all of these planning components comprise a reasonable assurance that implementation will progress as planned and will lead to restoration of water quality in Chestnut Creek.

9.4. Implementation Tracking

Tracking of agricultural practices will be done by the New River SWCD through the existing VADCR BMP Tracking Program. Tracking information will include the locations and numbers of practices installed in the watershed. Additional tracking of residential practices implemented using grant funding could also be tracked by the SWCD. Any other grant funded projects, including educational program and outreach activities, will be tracked as a component of the grant application or contract. The New River SWCD will provide oversight and direction as needed during implementation.

9.5 Water Quality Monitoring

Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (WQMIRA) requires that TMDL IPs include measurable goals and milestones for attaining water quality standards. Implicit in those milestones is the requirement of a method to measure progress. Post-Implementation Plan monitoring will help evaluate the effectiveness of implemented BMPs and progress toward the water quality milestones listed in this plan. Commonly, there is a lag between the completion of the Implementation Plan and any measurable changes in water quality. This can be due to the time needed for watershed stakeholders to organize, secure funding, and establish BMPs. VADEQ implementation monitoring should begin no sooner than two years following the initiation of documented TMDL implementation. Beginning implementation monitoring after two or more years of implementation will help ensure that sufficient time has passed for remedial measures to have stabilized and BMPs to have become functional.

Since, the main goal of implementation monitoring is to de-list the stream segments for all impairments; VADEQ will focus its monitoring resources on the original listing stations (Table 9-4). De-listing occurs when the original listing stations meet water quality criteria for the listed impairment(s). Thus, when significant implementation progress towards reducing bacteria and sediment loads in Chestnut Creek has been made, VADEQ will begin monitoring the initial listing stations for bacteria bimonthly for a period of four years. For the benthic impairment,

VADEQ biologists will monitor the original listing station in the spring and fall for approximately two years. If VADEQ is unable to de-list Chestnut Creek for bacteria and/or sediment in these timeframes, additional monitoring may be scheduled for the express purpose of trying to de-list the stream.

Table 9-4. VADEQ monitoring stations in the Chestnut Creek watershed.

VADEQ Station ID	Station Type	Location
9-CST002.64	Ambient, Biological	Bridge # 6002 on Rt. 793 off Rt. 607, off Rt. 721
9-CST016.82	Ambient	Private Bridge off Rt. 608, off Rt. 97

Additional monitoring beyond what VADEQ can provide with its limited resources may be conducted in Chestnut Creek. Citizen monitoring is a useful tool for measuring improvements in water quality. These efforts are encouraged and stakeholders should work together to distribute monitoring resources throughout the watershed to best capture implementation needs and progress. The New River Conservancy's citizen science program is one source that offers support for citizen monitoring efforts. Virginia Save Our Streams is a program of the Izaak Walton League of America that trains individuals in biological monitoring methods.

9.6 Evaluation of Progress

During each periodic evaluation of implementation progress in the Chestnut Creek watershed, a reassessment of implementation priorities will be made by the Steering Committee to readjust and fine-tune the targeting approach in concert with the staged implementation approach. Periodic re-evaluation is especially critical during these times of economic uncertainty, where increasing energy prices and fluctuating market prices are bound to affect stakeholders in the agricultural sector and their willingness to commit resources for conservation, especially if they are struggling to maintain their viability as a farming enterprise.

If reasonable progress toward implementing the management practices is not demonstrated, the Steering Committee will consider additional implementation actions. If it is demonstrated that reasonable and feasible management measures have been implemented for a sufficient period of time and TMDL targets are still not being met, the TMDL will be reevaluated and revised accordingly. If after ten years the Steering Committee determines that load reductions are being achieved as management measures are implemented, then the recommended appropriate course of action would be to continue management measure implementation and compliance oversight. If it is determined that all proposed control measures have been implemented, yet the TMDL is not achieved, further investigations will be made to determine whether: 1) the control measures are not effective; 2) bacteria loads are due to sources not previously addressed; or 3) the TMDL is unattainable.

9.7 Targeting

Staged implementation implies the process of targeting BMPs to get the "most bang for the buck" in the watershed. Targeting different BMPs across the stages optimizes the use of limited resources by focusing on the most cost-efficient practices and those that present the least obstacles (acceptance by landowners, available cost-share, etc.). For example, stream exclusion practices (SL-6, SL-6T, LE-1T, LE-2T, and WP-2T) are considered 100% effective at removing bacteria entering the stream through direct deposition by livestock. Thus, the stream exclusion systems needed to protect perennial streams have been prioritized in Stage 1. Targeting of

critical areas for livestock exclusion fencing was accomplished through analysis of livestock bacteria loads and the estimated fencing requirements for each sub-watershed. An effort should be made to prioritize financial and technical resources for livestock exclusion fencing in sub-watershed **2**, followed by sub-watersheds **5** and **8** (Figure 9-1). Sub-watersheds 4, 6, and 7 have the lowest priority since they have the least pasture area next to streams.

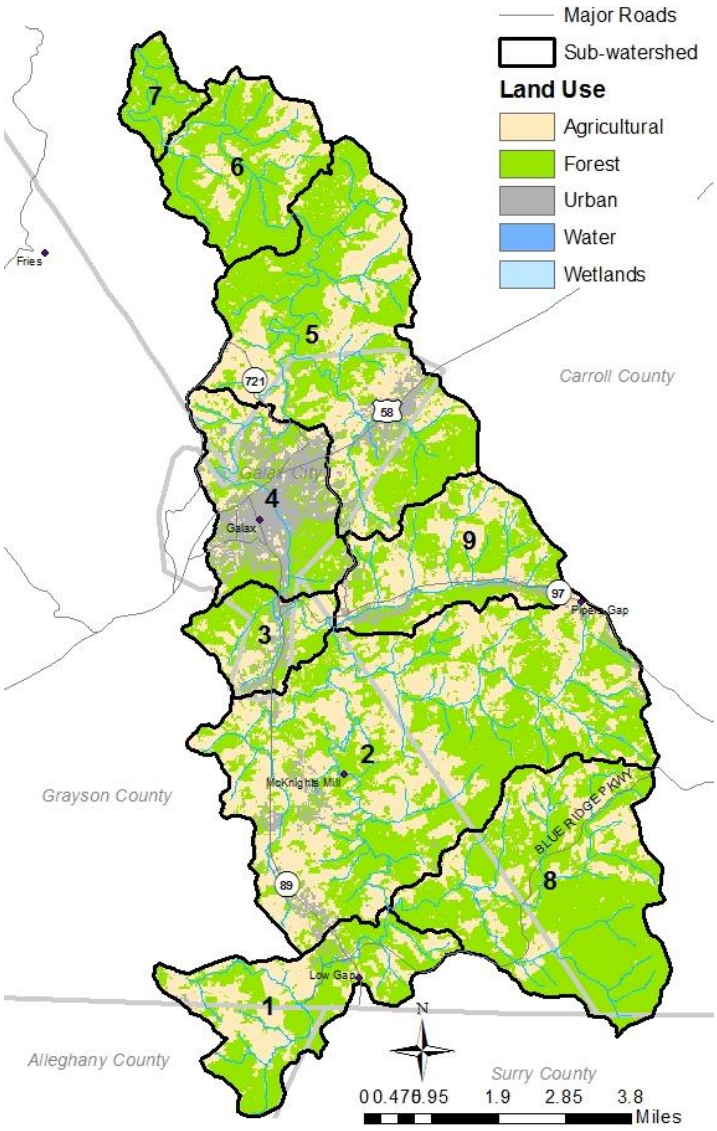

Figure 9-1.Delineated sub-watersheds in the Chestnut Creek watershed.

Similarly, practices that reduce bacteria from residential septic systems and straight pipes are also considered 100% efficient. The cost of these practices can often be offset by the procurement of grant funding, making them even more popular with local residents who directly benefit from maintaining or fixing their systems. Watershed inventory and modeling efforts suggest prioritizing sub-watershed **2**, followed by sub-watersheds **1** and **5**, to reduce bacteria loads from failing systems and straight pipes. Because sub-watersheds 6, 7, and 8 have very little residential area, they have the lowest priority.

Additional targeting for education and outreach efforts could be refined through GIS analysis. One option may be to utilize the Conservation Prioritization Project developed by the New River Land Trust (NRLT). Using ESRI's ArcGIS ModelBuilder, NRLT could identify key properties within the watershed based on characteristics such as location, presence of active agricultural production, size, erodibility of soils, slope, etc. Their model is based on a similar study done in South Carolina's Catawba River Basin which used GIS analysis to target education and outreach efforts to specific types of properties. During development of the Crab Creek TMDL Implementation Plan (VADEQ 2014), NRLT estimated the cost of such an effort, including staff time and actual outreach materials, to be around $9,300. This cost estimate is not included in the overall IP cost.

Table 9-5 lists the order of priorities by source category for Chestnut Creek watershed for each stage of implementation. For example, in Stage 1, addressing the human sources of bacteria has a higher priority over other sources in the Residential category, while livestock exclusion has a higher priority in addressing the bacteria and sediment sources in the Agricultural category. Factors used to develop BMP priorities were human and livestock health risks, effectiveness of practice, stakeholder interest, costs, and ease of installation. The distribution of implementation milestones listed in Table 9-3 correspond with these priorities.

Table 9-5. Implementation priorities for meeting water quality goals in the Chestnut Creek watershed.

Stage 1 Priorities	Stage 2 Priorities
Residential • Straight pipes • Failing septic systems • Urban/residential stormwater • Pet waste	**Residential** • Failing septic systems
Agricultural • Livestock exclusion systems • Improved pasture management • Permanent vegetative cover on critical areas • Reforestation of erodible pasture • Continuous no-till • Cover crops	**Agricultural** • Loafing lot management • Permanent vegetative cover on critical areas • Reforestation of erodible pasture • Animal waste storage facility • Water control structures
Stream Restoration • Streambank stabilization	
Other • Agricultural and residential technical assistance • Outreach and education	**Other** • Agricultural and residential technical assistance • Outreach and education

10. STAKEHOLDER ROLES AND RESPONSIBILITIES

Stakeholders are individuals who live or have land management responsibilities in the watershed, including government agencies, businesses, private individuals, and special interest groups. Stakeholder participation and support is essential for achieving the goals of this TMDL effort (i.e., improving water quality and removing streams from the impaired waters list). The purpose of this chapter is to identify and define the roles of the stakeholders who will work together to put the IP into practice. The roles and responsibilities of some of the major stakeholders are described below.

10.1 Federal Government

Farm Service Agency (FSA)

The U.S. Department of Agriculture, Farm Service Agency is primarily tasked with the implementation of farm conservation and regulation laws around the country. They oversee a number of voluntary conservation-related programs that work to address a large number of farming and ranching related conservation issues, including drinking water protection, reducing soil erosion, wildlife habitat preservation, and the preservation and restoration of forests and wetlands. These programs include the Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP).

Natural Resource Conservation Service (NRCS)

The U.S. Department of Agriculture, Natural Resources Conservation Service is the federal agency that works hand-in-hand with US citizens to conserve natural resources on private lands. NRCS assists private landowners with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on the expertise of NRCS staff. NRCS is also a major funding stakeholder for impaired water bodies through CREP and the Environmental Quality Incentive Program (EQIP). For more information on NRCS, visit http://www.nrcs.usda.gov/.

United States Environmental Protection Agency (USEPA)

The United States Environmental Protection Agency (USEPA) has the responsibility of overseeing the various programs necessary for the success of the CWA. However, administration and enforcement of such programs falls largely to the states.

10.2 State Government

In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions.

Virginia Department of Environmental Quality

The State Water Control Law authorizes the State Water Control Board to control and plan for the reduction of pollutants impacting the chemical and biological quality of the State's waters resulting in the degradation of the swimming, fishing, shell fishing, aquatic life, and drinking water uses. For many years the focus of VADEQ's pollution reduction efforts was the treated effluent discharged into Virginia's waters via the VPDES permit process. The TMDL process has expanded the focus of VADEQ's pollution reduction efforts from the effluent of wastewater treatment plants to the NPS pollutants causing impairments of the streams, lakes, and estuaries. The reduction tools are being expanded beyond the permit process to include a variety of voluntary strategies and BMPs.

VADEQ is the lead agency in the TMDL process. The Code of Virginia directs VADEQ to maintain a list of impaired waters and develop TMDLs for these waters. VADEQ administers the TMDL process, including the public participation component, and formally submits the TMDLs to USEPA and the State Water Control Board for approval. VADEQ is also responsible for implementing point source WLAs, assessing water quality across the state, and conducting water quality standard related actions. The Code also requires the development of IPs for the TMDLs. VADEQ is providing funding for the development of this IP.

Virginia Department of Agriculture and Consumer Services
Through Virginia's Agricultural Stewardship Act, the VDACS Commissioner of Agriculture has the authority to investigate claims that an agricultural producer is causing a water quality problem on a case-by-case basis. If deemed a problem, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district. If a producer fails to implement the plan, corrective action can be taken which can include a civil penalty up to $5,000 per day. The Commissioner of Agriculture can issue an emergency corrective action if runoff is likely to endanger public health, animals, fish and aquatic life, public water supply, etc. An emergency order can shut down all or part of an agricultural activity and require specific stewardship measures. The enforcement of the Agricultural Stewardship Act is entirely complaint-driven. This Act is considered as a state regulatory tool that can support implementing conservation practices to address pollutant sources in TMDL impaired watersheds.

Virginia Department of Conservation and Recreation
The Virginia Department of Conservation and Recreation (VADCR) will work closely with project partners including the New River Soil and Water Conservation District to track implementation progress and provide cost share for agricultural best management practices through the Virginia Agricultural Cost Share Program. In addition, VADCR will provide support to improve the implementation process through utilization of existing authorities and resources.

Virginia Department of Forestry (VADOF)
The VADOF has prepared a manual to inform and educate forest landowners and the professional forest community on proper BMPs and technical specifications for installation of these practices in forested areas (http://www.dof.virginia.gov/wq/index-BMP-Guide). Forestry BMPs are directed primarily to control erosion. For example, streamside forest buffers provide nutrient uptake and soil stabilization, which can benefit water quality by reducing the amount of nutrients and sediments that enter local streams. VADOF's BMP program is voluntary.

Virginia Department of Game and Inland Fisheries (VDGIF)
The VDGIF manages Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth; provides opportunity for all to enjoy wildlife, inland fish, boating, and related outdoor recreation; and promotes safety for persons and property in connection with boating, hunting and fishing. The VDGIF has responsibility for administering certain U.S. Fish and Wildlife Service funding programs. Personnel participate, review, and comment on projects processed through state and federal project and permitting review processes to insure the consideration for fish and wildlife populations and associated habitats.

Virginia Department of Health (VDH)
VDH is responsible for maintaining safe drinking water measured by standards set by EPA. Their duties also include septic system regulation and, in the past, regulation of biosolids land application. Like VDACS, VDH's program is complaint-driven. Complaints can range from a vent pipe odor that is not an actual sewage violation and takes very little time to investigate, to a large discharge violation that may take many weeks or longer to effect compliance. In the scheme of this TMDL IP, VDH has the responsibility of enforcing actions to correct or eliminate failed septic systems and straight pipes, respectively. VDH staff also issue permits for the repair and installation of septic systems and the installation of alternative waste treatment systems.

Virginia Cooperative Extension (VCE)
Another state entity with responsibilities for activities that impact water quality in the watersheds is the Virginia Cooperative Extension (VCE). VCE is an educational outreach program of Virginia's land grant universities (Virginia Tech and Virginia State University), and a part of the national Cooperative State Research, Education, and Extension Service, an agency of the United States Department of Agriculture. VCE is a product of cooperation among local, state, and federal governments in partnership with citizens. VCE offers educational programs and technical resources for topics such as crops, grains, livestock, poultry, dairy, natural resources, and environmental management. VCE has published several publications that deal specifically with TMDLs. For more information on these publications and to find the location of county extension offices, visit http://www.ext.vt.edu/.

10.3 Regional and Local Government

Carroll and Grayson Counties, City of Galax
Decisions made by local governments regarding land use will play an important role in the implementation of this plan. This makes the Grayson and Carroll County Boards of Supervisors, the Galax City Council, and the three jurisdictional Planning Commissions key partners in long term implementation efforts. Currently, both counties have land use policies in place that support the preservation of agricultural land and encourage good stewardship of natural resources. Local government support of land conservation will become increasingly important as greater numbers of conservation measures are implemented across the watersheds. Ensuring the protection of land in agriculture and forest will allow the practices installed to continue to benefit water quality. The City of Galax Public Works Department is another key local government partner with respect to identifying opportunities to connect homes with failing septic systems to public sewer.

Mount Rogers Planning District Commission
The Mount Rogers Planning District serves the local governments in the counties of Bland, Carroll, Grayson, Smyth, Washington, and Wythe and the Cities of Bristol and Galax and their citizenry by providing a number of different services ranging from economic development to transportation planning. The purpose of the planning district commission is to promote regional cooperation, to coordinate the activities and policies of member local governments, and to provide planning assistance to local governments. The commission is financed by a combination of local, state, and federal funds. The commission could serve as a grant project partner and/or manager during implementation.

New River Soil and Water Conservation District (SWCD) and NRCS
During project implementation, the New River SWCD and the local NRCS office should continue and if possible expand outreach efforts in Chestnut Creek to both agricultural producers and community members. These organizations will be the primary technical and financial resource for implementing the agricultural practices in this plan. Their responsibilities include promoting BMP funding and benefits and assisting with BMP development on individual properties. Outreach activities should specifically encourage participation of Chestnut Creek farmers in the BMPs outlined in this plan to reduce bacteria and sediment loads. Outreach activities may include mailing newsletters, planning field days, and giving presentations. The New River SWCD works throughout the counties of Grayson and Carroll and the city of Galax. It is recommended that a technician be hired and devoted at least part-time to water quality efforts in the Chestnut Creek watershed.

10.4 Businesses, Community Groups, and Citizens

While successful implementation depends on stakeholders taking responsibility for their role in the process, the primary role falls on the local groups that are most affected; that is, businesses, community watershed groups, and citizens. Virginia's approach to correcting non-point source pollution problems continues to be encouragement of participation through education and financial incentives; that is, outside of the regulatory framework. If, however, voluntary approaches prove to be ineffective, it is likely that implementation will become less voluntary and more regulatory.

New River Conservancy
The New River Conservancy works with landowners and citizens to conserve critical lands, restore riparian areas, and advocate for the protection of the New River throughout its multi-state watershed.

Agricultural Landowners
SWCD and NRCS conservation staff often consider characteristics of farms and farmers in the watersheds that will affect the decisions farmers make when it comes to implementing conservation practices. For example, the average size of farms is an important factor to consider, since it affects how much cropland or pasture a farmer can give up for a riparian buffer. The age of a farmer may also influence their decision to implement best management practices. Table 10-1 provides a summary of relevant characteristics of farms and producers in Carroll and Grayson Counties from the 2012 Agricultural Census. These characteristics were considered when developing implementation scenarios, and should be utilized to develop suitable education and outreach strategies.

Table 10-1. Characteristics of farms and farmers in Carroll and Grayson Counties.

Characteristic		Carroll	Grayson
Number of farms		980	764
Land in farms (acres): full owners		43,639	46,718
Land in farms (acres): part owners	Rented land in farms	49,718	45,644
	Owned land in farms	43,128	35,024
Tenants		44	42
Operators identifying farming as their primary occupation		384	338
Operators identifying something other than farming as their primary occupation		596	426
Average age of primary operator		58.3	58.9
Average size of farm (acres)		143	173
Average value of farmland ($/acre)		$3,406	$4,195
Average net cash farm income of operation ($)		$3,146	$3,762
Average farm production expenses ($)		$43,021	$39,928
Farms with internet access		590	446

Residential Landowners

In addition to local farmers, participation from homeowners is also critical to the success of this plan. Residential property owners will need to ensure that their septic systems are regularly pumped and inspected (every 3-5 years). Though the amount of bacteria that is coming from failing septic systems and straight pipes is minimal compared to livestock, human waste needs to be removed since it carries with it pathogens that can cause health problems above and beyond those associated with livestock manure. Residential property owners can also improve water quality by eliminating pet waste runoff from yards and implementing practices, such as rain gardens and riparian buffers, to reduce stormwater carrying bacteria and sediment to Chestnut Creek.

There are numerous additional opportunities for future partnerships in the implementation of this plan and the partnership noted above. Additional potential partners in implementation include:

- County and city schools
- Master Gardeners of the Blue Ridge
- New River Highlands RC&D
- New River Land Trust
- Trout Unlimited
- Virginia Farm Bureau
- Virginia Outdoors Foundation
- Virginia Save Our Streams

11. INTEGRATION WITH OTHER WATERSHED PLANS

Like most watersheds in Virginia, water quality in the Chestnut Creek watershed is a component of many different organizations, programs and activities. Such efforts include, but are not limited to, watershed implementation plans, TMDLs, Roundtables, Water Quality Management Plans, Erosion and Sediment Control Regulations, Stormwater Management Programs, Source Water Assessment Programs, local comprehensive and strategic plans, and local environmentally-focused organizations. These efforts should be evaluated to determine their potential impacts on the implementation goals outlined in this clean-up plan. Often, these efforts are related or collaborative, but this is not always the case. Coordination of local programs can increase participation and prevent redundancy.

12. POTENTIAL FUNDING SOURCES

This list of potential funding resources is a compilation of sources from other Virginia Implementation Plans as well as ideas from local stakeholders. Detailed descriptions of the agricultural cost-share programs can be obtained from the New River SWCD, VA Department of Conservation and Recreation, Natural Resources Conservation Service and the Virginia Cooperative Extension.

12.1 Federal

Federal Clean Water Act Section 319 Incremental Funds

Through Section 319 of the Federal Clean Water Act, Virginia is awarded grant funds to implement the nonpoint source programs. VADEQ reports annually to the EPA on the progress made in nonpoint source pollution prevention and control. Stakeholder organizations can apply annually, on a competitive basis, for 319 grants to implement BMPs and educational components included in a TMDL IP.

USDA – FSA

Conservation Reserve Program (CRP)

Through this program, cost-share assistance is available to establish cover of trees or herbaceous vegetation on cropland. Offers for the program are ranked, accepted and processed during fixed signup periods that are announced by FSA. If accepted, contracts are developed for a minimum of 10 and not more than 15 years. Payments are based on a per-acre soil rental rate. To be eligible for consideration, the following criteria must be met: 1) cropland was planted or considered planted in an agricultural commodity for two of the five most recent crop years and 2) cropland is classified as "highly-erodible" by NRCS. Application evaluation points can be increased if certain tree species, spacing, and seeding mixtures that maximize wildlife habitats are selected. Land must have been owned or operated by the applicant for at least 12 months prior to the close of the signup period. The payment to the participant is up to 50% of the cost for establishing ground cover. Incentive payments for wetlands hydrology restoration equal 25% of the cost of restoration.

Conservation Reserve Enhancement Program (CREP)

This program is an "enhancement" of the existing USDA CRP Continuous Sign-up. It has been "enhanced" by increasing the cost-share rates from 50% to 75% and 100%, increasing the rental rates, and offering a flat rate incentive payment to place a permanent "riparian easement" on the enrolled area. Pasture and cropland (as defined by USDA) adjacent to streams, intermittent streams, seeps, springs, ponds and sinkholes are eligible to be enrolled. Cost-sharing (75% - 100%) is available to help pay for fencing to exclude livestock from the riparian buffer, watering facilities, hardwood tree planting, filter strip establishment, and wetland restoration. In addition, a 40% incentive payment upon completion is offered and an average rental rate of $70/acre on stream buffer area for 10-15 years. The State of Virginia will make an additional incentive payment to place a perpetual conservation easement on the enrolled area. Landowners can obtain and complete CREP application forms at their local FSA center.

USDA - NRCS

Conservation Stewardship Program

The Conservation Stewardship Program (CSP) is a voluntary program that encourages agricultural and forestry producers to address resource concerns by (1) undertaking additional conservation activities and (2) improving and maintaining existing conservation systems. CSP provides financial and technical assistance to help land stewards conserve and enhance soil, water, air, and related natural resources on their land. CSP is available to all producers, regardless of operation size or crops produced. Eligible lands include cropland, grassland, prairie land, improved pastureland, rangeland, nonindustrial private forest land, and agricultural land. NRCS makes CSP available on a nationwide basis through continuous sign-up, with announced cut-off dates for ranking and funding applications. CSP pays participants for conservation performance—the higher the performance, the higher the payment. It provides two possible types of payments. An annual payment is available for installing new conservation activities and maintaining existing practices. A supplemental payment is available to participants who also adopt a resource conserving crop rotation.

Environmental Quality Incentives Program (EQIP)

This program was established in the 1996 Farm Bill to provide a single voluntary conservation program for farmers and landowners to address significant natural resource needs and objectives. Approximately 65% of the EQIP funding for the state of Virginia is directed toward "Priority Areas." These areas are selected from proposals submitted by a locally led conservation work group. Proposals describe serious and critical environmental needs and concerns of an area or watershed, and the corrective actions they desire to take to address these needs and concerns. The remaining 35% of the funds are directed toward statewide priority concerns of environmental needs. EQIP offers 5 to 10-year contracts to landowners and farmers to provide 75% cost-share assistance, 25% tax credit, and/or incentive payments to implement conservation practices and address the priority concerns statewide or in the priority area. Eligibility is limited to persons who are engaged in livestock or agricultural production. Eligible land includes cropland, pasture, and other agricultural land in priority areas, or land that has an environmental need that matches one of the statewide concerns.

Agricultural Conservation Easement Program (ACEP)

The 2014 Farm Bill authorized $1 billion in funding for the new Agricultural Conservation Easement Program (ACEP), which consolidates the former Farm and Ranch Lands Protection Program (FRPP), Grassland Reserve Program (GRP) and Wetlands Reserve Program (WRP) into a single program. This program will provide grants to purchase conservation easements that permanently restrict development on important farmland and reward landowners who participate in the program with permanent tax breaks.

United States Fish and Wildlife Service

The US Fish and Wildlife Service (USFWS) administers a variety of natural resource assistance grants to governmental, public and private organizations, groups and individuals. Natural resource assistance grants are available to state agencies, local governments, conservation organizations, and private individuals.

12.2 State

Virginia Agricultural Best Management Practices (BMPs) Cost-Share Program

The cost-share program is funded with state and federal monies through local Soil and Water Conservation Districts (SWCDs). SWCDs administer the program to encourage farmers and landowners to use BMPs on their land to better control transportation of pollutants into our waters due to excessive surface flow, erosion, leaching, and inadequate animal waste management. Program participants are recruited by SWCDs based upon those factors, which have a great impact on water quality. Cost-share is typically 75% of the actual cost, not to exceed the local maximum.

Virginia Agricultural Best Management Practices Loan Program

The purpose of the Virginia Land Conservation Loan Program is to provide a long term source of low interest financing for the conservation of land in Virginia in order to improve and/or protect the water resources of the Commonwealth. Additional benefits of the program include the protection of open space or natural values of the properties and/or the assurance of the availability of the land for agricultural, forest, recreation, or open space use. Although these other benefits are of value, the principle focus and utilization of the Fund is on beneficial impact to water quality.

Loan requests are accepted through VADEQ. The interest rate is 3% per year and the term of the loan coincides with the life span of the practice. To be eligible for the loan, the BMP must be included in a conservation plan approved by the local SWCD Board. The minimum loan amount is $5,000; there is no maximum limit. Eligible BMPs include structural practices such as animal waste control facilities, loafing lot management systems, and grazing land protection systems. The loans are administered through participating lending institutions.

Virginia Agricultural Best Management Practices Tax Credit Program

For all taxable years, any individual or corporation engaged in agricultural production for market, who has in place a soil conservation plan approved by the local SWCD, is allowed a credit against the tax imposed by Section 58.1-320 of an amount equaling 25% of the first $70,000 expended for agricultural best management practices by the individual. Any practice approved by the local SWCD Board must be completed within the taxable year in which the credit is claimed. The credit is only allowed for expenditures made by the taxpayer from funds of his/her own sources. The amount of the credit cannot exceed $17,500 or the total amount of the tax imposed by this program (whichever is less) in the year the project was completed. If the amount of the credit exceeds the taxpayer's liability for such taxable year, the excess may be carried over for credit against income taxes in the next five taxable years until the total amount of the tax credit has been taken. This program can be used independently or in conjunction with other cost-share programs on the stakeholder's portion of BMP costs. It is also approved for use in supplementing the cost of repairs to streamside fencing.

Virginia Clean Water Revolving Loan Fund

EPA awards grants to states to capitalize their Clean Water State Revolving Funds (CWSRFs). The states, through the CWSRF, make loans for high-priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. Eligible projects include point source, nonpoint source and estuary protection

projects. Point source projects typically include building wastewater treatment facilities, combined sewer overflow and sanitary sewer overflow correction, urban stormwater control, and water quality aspects of landfill projects. Nonpoint source projects include agricultural, silvicultural, rural, and some urban runoff control; on-site wastewater disposal systems (septic tanks); land conservation and riparian buffers; leaking underground storage tank remediation, etc.

Virginia Department of Environmental Quality Citizen Water Monitoring Grant Program
The primary purpose of the Virginia Department of Environmental Quality Citizen Water Monitoring Grant Program is to provide funding for water quality monitoring groups and individuals to monitor the quality of Virginia's waters. The grant can be used in a variety of ways, including purchasing water quality monitoring equipment, training citizen volunteers, lab analysis costs, and promoting stream monitoring efforts in locations where DEQ is not currently collecting water quality samples. To be eligible for funding under the regular Citizen Monitoring Grant, a grantee must follow certain guidelines, including developing a quality assurance project plan (QAPP).

Virginia Forest Stewardship Program
The purpose of the Forest Stewardship Program is to encourage the long-term stewardship of nonindustrial private forest lands, by assisting the owners of such lands to more actively manage their forest and related resources. The Forest Stewardship Program provides assistance to owners of forest land and other lands where good stewardship, including agroforestry applications, will enhance and sustain the long term productivity of multiple forest resources. Special attention is given to landowners in important forest resource areas and those new to, or in the early stages of managing their land in a way that embodies multi-resource stewardship principles. The program provides landowners with the professional planning and technical assistance they need to keep their land in a productive and healthy condition. The planning assistance offered through the Forest Stewardship Program may also provide landowners with enhanced access to other USDA conservation programs and/or forest certification programs.

Private nonindustrial forest lands that are managed under existing Federal, State, or private sector financial and technical assistance programs are eligible for assistance under the Forest Stewardship Program. Forest resource management activities on such forest lands must meet, or be expanded or enhanced to meet the requirements of the Forest Stewardship Program. Participation in the Forest Stewardship Program is voluntary. To enter the program, landowners agree to manage their property according to an approved Forest Stewardship Management Plan. Landowners also understand that they may be asked to participate in future management outcome monitoring activities.

Virginia Outdoors Foundation (VOF)
Conservation easements are voluntary agreements that allow individuals or groups to limit the type or amount of development on their property. Easements typically describe the resource they are designed to protect (e.g., agricultural, forest, historic, or open space). Conservation easements may indirectly contribute to water quality protection due to the restrictions on future development. The Virginia Outdoors Foundation is the state's largest holder of conservation easements. While their easements do not require riparian buffers, they do strongly encourage

them along all streams, rivers, or other significant water resources on a conserved property. A gift of a permanent open-space easement may qualify as a charitable gift and be eligible for certain state and federal tax benefits. In addition, there may be local property tax reductions and federal estate tax exemptions. VOF also administers the *Open Space Lands Preservation Trust Fund*, which assists landowners with the costs of conveying open-space easements and purchases all or part of the value of easements. Priority for funding is given to applications on family farms and for those with demonstrated financial need.

Virginia Small Business Environmental Assistance Fund Loan Program
The Fund, administered through VADEQ, is used to make loans or to guarantee loans to small businesses for the purchase and installation of environmental pollution control equipment, equipment to implement voluntary pollution prevention measures, or equipment and structures to implement agricultural BMPs. The equipment must be needed by the small business to comply with the federal Clean Air Act, or it will allow the small business to implement voluntary pollution prevention measures. The loans are available in amounts up to $50,000 and will carry an interest rate of 3%, with favorable repayment terms based on the borrower's ability to repay and the useful life of the equipment being purchased or the life of the BMP being implemented. There is a $30 non-refundable application processing fee. The Fund will not be used to make loans to small businesses for the purchase and installation of equipment needed to comply with an enforcement action. To be eligible for assistance, a business must employ 100 or fewer people and be classified as a small business under the federal Small Business Act.

Virginia Stormwater Assistance Fund (SLAF)
SLAF funds stormwater projects including: 1) new stormwater best management practices, 2) stormwater best management practices retrofits, 3) stream restoration, 4) low impact development projects, 5) buffer restorations, 6) pond retrofits, and 7) wetlands restoration. Eligible recipients are local governments, meaning any county, city, town, municipal corporation, authority, district, commission, or political subdivision created by the General assembly or pursuant to the Constitution or laws of the Commonwealth. The fund is administered by VADEQ.

Virginia Water Quality Improvement Fund
This is a permanent, non-reverting fund established by the Commonwealth of Virginia in order to assist local stakeholders in reducing point and nonpoint nutrient loads to surface waters. Eligible recipients include local governments, SWCDs, and individuals. Grants for point sources and nonpoint sources are administered through VADEQ. Most WQIF grants provide matching funds on a 50/50 cost-share basis.

12.3 Regional and Private Sources

Community Development Block Grants (CDBG)
The Community Development Block Grant (CDBG) program is a flexible program that provides communities with resources to address a wide range of unique community development needs. Over a 1, 2, or 3-year period, as selected by the grantee, not less than 70 percent of CDBG funds must be used for activities that benefit low- and moderate-income persons. In addition, each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and

immediate threat to the health or welfare of the community for which other funding is not available.

National Fish and Wildlife Foundation (NFWF)

Five Star and Urban Waters Restoration Grant Program

The NFWF's Five Star and Urban Waters Restoration Program seeks to develop nation-wide-community stewardship of local natural resources, preserving these resources for future generations and enhancing habitat for local wildlife. Projects seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. The program requires the establishment and/or enhancement of diverse partnerships and an education/outreach component that will help shape and sustain behavior to achieve conservation goals. The Five Star program provides $20,000 to $50,000 grants with an average award size of $25,000. Grants that are in the $30,000-$50,000 range are typically two years and are in urban areas.

Funding priorities for this program include:

- On-the-ground wetland, riparian, in-stream and/or coastal habitat restoration
- Meaningful education and training activities, either through community outreach, participation and/or integration with K-12 environmental curriculum
- Measurable ecological, educational and community benefits
- Partnerships: Five Star projects should engage a diverse group of community partners to achieve ecological and educational outcomes

Norcross Wildlife Foundation

The Norcross Wildlife Sanctuary in Monson, Massachusetts was founded in 1939 by Arthur Norcross and the Norcross Wildlife Foundation was founded in 1964 after his passing. The Foundation provides grants to environmental conservation NGOs primarily for the purchase of office and field equipment as well as publications and other educational materials that have a practical, immediate use. Grant requests may be up to $10,000, but awards generally average less than $5,000. Examples of funded projects include computers, cameras, GPS units, GIS software, data loggers, and water quality testing materials.

Southeast Rural Community Assistance Project (SERCAP)

The mission of this project is to promote, cultivate, and encourage the development of water and wastewater facilities to serve low-income residents at affordable costs and to support other development activities that will improve the quality of life in rural areas. Staff members of other community organizations complement the SE/R-CAP staff across the region. They can provide (at no cost): on-site technical assistance and consultation, operation and maintenance/management assistance, training, education, facilitation, volunteers, and financial assistance. Financial assistance includes $1,500 toward repair/replacement/ installation of a septic system and $2,000 toward repair/replacement/installation of an alternative waste treatment system. Funding is only available for families making less than 125% of the federal poverty level.

Virginia Environmental Endowment

The Virginia Environmental Endowment is a nonprofit, independent grant-making foundation whose mission is to improve the quality of the environment by using its capital to encourage all

sectors to work together to prevent pollution, conserve natural resources, and promote environmental literacy. Current grant-making priorities in Virginia include improving local rivers and protecting water quality throughout Virginia, Chesapeake Bay restoration, enhancing land conservation and sustainable land use, advancing environmental literacy and public awareness, and supporting emerging issues in environmental protection. Applications are accepted biannually with deadlines of June 15th and December 1st.

Wetland and Stream Mitigation Banking

Mitigation banks are sites where aquatic resources such as wetlands, streams and streamside buffers are restored, created, enhanced, or in exceptional circumstances, preserved expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources. Mitigation banking is a commercial venture that provides compensation for aquatic resources in financially and environmentally preferable ways. Not every site or property is suitable for mitigation banking. Mitigation banks are required to be protected in perpetuity, to provide financial assurances and long term stewardship. The mitigation banking process is overseen by an Inter-Agency Review Team made up of state and federal agencies and chaired by VADEQ and Army Corps of Engineers.

REFERENCES

Alderfer RB and Robinson RR. 1947. Runoff from pastures in relation to grazing intensity and soil compaction. Journal of American Society of Agronomy. 39: 948-958.

Alderserio K, Wait D and Sobsey M. 1996. Detection and characterization of male-specific RNA Coliphages in a New York City reservoir to distinguish between human and non-human sources of contamination. Proceedings of a Symposium on New York City Water Supply Studies, ed. McDonnell et al. TPS-96-2. American Water Resources Association. Herndon, VA.

Benedict MA and McMahon ET. 2006. Green infrastructure. Island Press: Washington. 300pp.

Bockstael NE, Freeman III AM, Kopp RJ, Portney PR, and Smith VK. 2000. On measuring economic values for nature. Environmental Science & Technology 34: 1384-1389.

CDC. 1995. *Escherichia coli* 0157:H7 outbreak at a summer camp – Virginia, 1994. CDC MMWR Weekly. June 9, 1995. 44(22); 419-421.

CDC. 2001. Outbreaks of *Escherichia coli* 0157:H7 infections among children associated with farm visits --- Pennsylvania and Washington, 2000. CDC MMWR. April 20, 2001. 50(15); 293-297.

Clark S, Grose M, Greer R, Jarrett A, Kunkel S, Lake D, Law N, McCutcheon J, McLaughlin R, Mumaw K, Young B. 2014. Recommendations of the expert panel to define removal rates for erosion and sediment control practices. Prepared by Hanson J, Chesapeake Research Consortium and Schueler T and Lane C, Chesapeake Stormwater Network. 110p.

EPA. 2000. Stressor identification guidance document. EPA-822-B-00-025. U. S. Environmental Protection Agency, Office of Water and Office of Research and Development. Washington, D.C.

EPA. 2014. Preventing septic system failure. < http://water.epa.gov/polwaste/npdes/swbmp/Preventing-Septic-System-Failure.cfm>.

Hardwick N. 1997. Lake Sammamish watershed water quality survey. King County Water and Land Resources Division, Seattle, WA. 122 pp.

Harrison ET, Norris RH, and Wilkinson SN. 2007. The impact of fine sediment accumulation on benthic macroinvertebrates: implications for river management. Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference. Charles Sturt University, Thurgoona, New South Wales.

Heintz J, Pollin R, and Garrett-Peltier H. 2009. How infrastructure investments support the U.S. economy. Political Economy Research Institute, Amherst, MA. <http://www.peri.umass.edu/236/hash/efc9f7456a/publication/333 >.

Jones GM and Balley, Jr. TL. 2009. Understanding the basics of mastitis. Virginia Cooperative Extension 404-233.

Leggett CG and Bockstael NE. 2000. Evidence of the effects of water quality on residential land prices. Journal of Environmental Economic and Management 39: 121-144.

Luloff AE, Hoag DLK, Osmond DL, Woods BR, Gordon JS, Gruver J, Roka K, Raboanarielina CM, Longmire C, Ward M, and Weigle JL. 2012. Chapter 2: Key informant survey to understand what farmers, agency personnel, and stakeholders think: National institute of food and agriculture – conservation effects assessment project.

Medina DE, Monfils J, and Baccata Z. 2011. Green infrastructure benefits for floodplain management: a case study. Stormwater: The Journal for Surface Water Quality Professionals.

NVPDC. 2005. NVPDC's dog park BMP pilot project: Making the connection between dog waste and bacteria contamination in streams. <http://www.myxyz.org/phmurphy/dog/NorthVirginia%20Dog%20Park%20BMP%20Pilot%20Project.pdf>.

Osmond DL, Meals DW, Hoag DLK, and Arabi M, eds. 2012. How to Build Better Agricultural Conservation Programs to Protect Water Quality: The National Institute of Food and Agriculture–Conservation Effects Assessment Project Experience. Ankeny, IA: Soil and Water Conservation Society.

Roanoke Times. 1997a. *E. coli* cases pit health officials against boaters, swim at your own risk. Roanoke Times. November 9 1997. Page B1.

Roanoke Times. 1997b. Meeting taps concerns over lake's water quality, some want education, others regulation, to prevent sickness. Roanoke Times. November 15, 1997. Page B1

Roanoke Times. 1998a. Confirmed *E. coli* count now at 9. Roanoke Times. August 22, 1998.

Roanoke Times. 1998b. *E. coli* levels hard to track. Roanoke Times. October 19, 1998. Page C1.

Roanoke Times. 1998c. State tests confirm *E. coli* infections still no source determined. Roanoke Times. August 19, 1998.

Roanoke Times. 2000. Health dept. shuts off tap on Crystal Spring's water. Roanoke Times. June 6, 2000. Page A1.

Surber, G., K. Williams and M. Manoukian. 2005. Drinking water quality for beef cattle: an environmentally friendly and productive management enhancement technique. Animal and Range Sciences, Extension Service, Montana State University.

Syferd E. 1995. Water quality consortium research summary report. Seattle, WA; cited in Center for Watershed Protection.

U.S. Census Bureau (USCB). 2010. Census data for Virginia.

U.S. Department of the Interior (USDOI), U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2011 National survey of fishing, hunting, and wildlife-associated recreation. Virginia, revised 2014. < http://www.census.gov/prod/2013pubs/fhw11-va.pdf>.

VADCR. 2004. The Virginia stream restoration and stabilization best management practices guide. Virginia Department of Conservation and Recreation Division of Soil and Water Conservation. < http://www.deq.virginia.gov/Portals/0/DEQ/Water/Publications/BMPGuide.pdf >.

VADEQ. 2006. Total Maximum Daily Load Development for Chestnut Creek Fecal Bacteria and General Standard (Benthic). MapTech, Inc. and New River-Highlands Resource Conservation and Development. <http://www.deq.virginia.gov/portals/0/DEQ/Water/TMDL/apptmdls/newrvr/chestnut.pdf>.

VADEQ. 2014. Crab Creek Bacteria and Sediment TMDL Implementation Plan. Virginia Department of Environmental Quality. <http://www.deq.state.va.us/Portals/0/DEQ/Water/TMDL/ImplementationPlans/CrabCr_technical.pdf>.

VDACS. 2015. Virginia agriculture – facts and figures. <http://www.vdacs.virginia.gov/agfacts/>.

Zeckoski, R., Benham, B., Lunsford, C. 2007. Streamside livestock exclusion: A tool for increasing farm income and improving water quality. Biological Systems Engineering, Virginia Tech. Publication Number 442-766. September 2007. <http://pubs.ext.vt.edu/442/442-766/442-766.pdf>.

Appendix A. Best Management Practice Efficiency Information

Management Practice	Extent Units	% Effectiveness		Effectiveness Source		Cost/ Unit
		Bacteria	Sediment	Bacteria	Sediment	
Agricultural						
Livestock exclusion with riparian buffers (CRSL-6)	system	100	LUC*	1	4	$30,000
Livestock exclusion with grazing land management (SL-6, SL-6T, LE-1T)	system	100	LUC	1	4	$25,000
Livestock exclusion with reduced setback (LE-2T)	system	100	LUC	1	4	$20,000
Stream protection (WP-2T)	system	100	LUC	1	4	$10,000
Animal waste control facility – beef (WP-4)	system	80	NA	2	NA	$150,000
Continuous no-till system (SL-15A)	acres	64	64	2	5	$20
Cover crops (SL-8, SL-8B)	acres	20	20	2	5	$25
Improved pasture management (SL-7T, SL-9, SL-10T)	acres	50	30	3	5	$75
Loafing lot management system (WP-4B)	system	40	40	2	5	$20,000
Permanent vegetative cover on critical areas (SL-11)	acres	LUC	LUC	4	4	$2,000
Permanent vegetative cover on cropland (SL-1)	acres	LUC	LUC	4	4	$350
Reforestation of erodible crop and pastureland (FR-1)	acres	LUC	LUC	4	4	$120
Sediment retention, erosion or water control structures (WP-1)	acres treated	50	50	2	5	$140
Residential						
Septic tank pump outs (RB-1)	#	5	NA	3	NA	$300
New sewer hookups (RB-2)	#	100	NA	1	NA	$5,000
Septic system repairs (RB-3)	#	100	NA	1	NA	$3,500
New septic systems (RB-4, RB-4P)	#	100	NA	1	NA	$5,000
Alternative septic systems (RB-5)	#	100	NA	1	NA	$15,000
Pet waste stations	#	100	NA	8	NA	$3,000
Pet waste program	program	25	NA	6	NA	$4,000
Urban Stormwater						
Rain gardens	acres treated	90	90	2	5	$5,000
Riparian Buffers	acres installed	50	50	2	5	$500
Streambank						
Streambank stabilization	linear foot	0.075	44.88 lbs/ft/yr	9	7	$300

*LUC – land use conversion

APPENDIX A REFERENCES

1 - Removal efficiency is defined by the practice
2 - Bacteria efficiency assumed equal to sediment efficiency
3 - VADCR and VADEQ. 2003. Guidance Manual for Total Maximum Daily Load Implementation Plans
4 - Based on differential loading rates to different land uses
5 - Chesapeake Assessment Scenario Tool - BMP effectiveness values by land use and HGMR and pollutant
6 - Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112pp.
7 - Chesapeake Bay Program. 2013. Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects
8 – Removal efficiency is defined by the practice, estimates 10 pets/day
9 - Bacteria efficiency assumed equal to nitrogen removal efficiency - Chesapeake Assessment Scenario Tool - BMP effectiveness values by land use and HGMR and pollutant